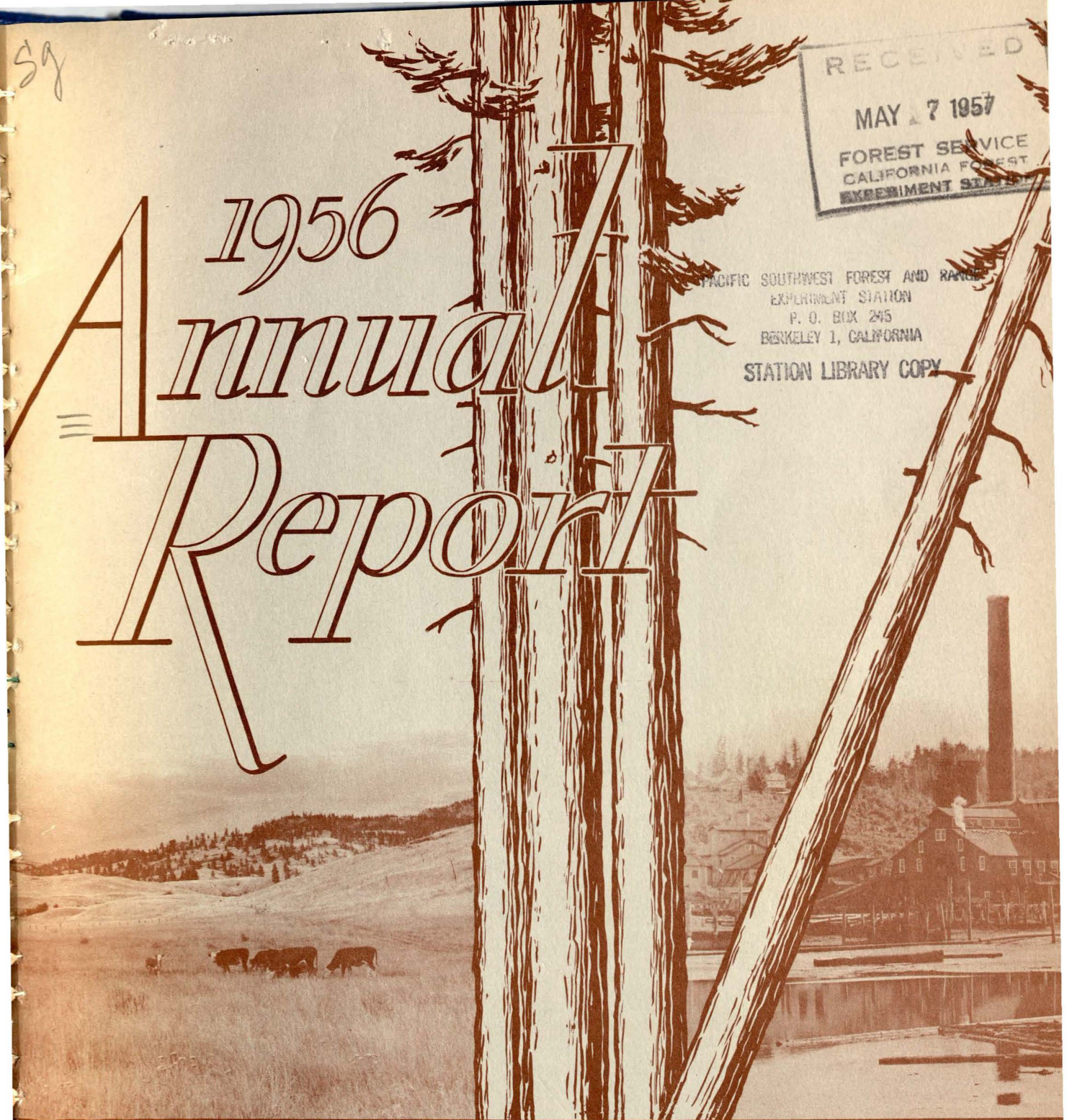


RECEIVED
MAY 7 1957
FOREST SERVICE
CALIFORNIA FOREST
EXPERIMENT STATION

PACIFIC SOUTHWEST FOREST AND RANGE
EXPERIMENT STATION
P. O. BOX 245
BERKELEY 1, CALIFORNIA
STATION LIBRARY COPY

1956 Annual Report

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION

R. W. COWLIN, DIRECTOR

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

PACIFIC SOUTHWEST FOREST AND RANGE
EXPERIMENT STATION
P. O. BOX 245
BERKELEY 1, CALIFORNIA
STATION LIBRARY COPY

1956

ANNUAL REPORT

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION

FOREST SERVICE U. S. DEPARTMENT OF AGRICULTURE

Portland, Oregon

April 1957

CONTENTS

INTRODUCTION i

FOREST DISEASE RESEARCH 1
Nursery and Plantation Diseases 1
Foliage Diseases 2
Stem Diseases and Decays 3
Root Diseases 4
Decays and Stains of Forest Products 5
Diseases Not of Project Status. 6
Cooperation 7
Plans for Forest Disease Research in 1957 7

FOREST ECONOMICS RESEARCH 9
Forest Survey Progress 9
Observations Based on Recently Reinventoried Counties . . 10
Joint Working Circle-Forest Survey Inventories 12
Supporting Studies in Lane County 13
Lumber Price Trends and Relationships 14
Forest Industry Production Levels in Oregon and Washington 16
Other Divisional Activities 16
Plans for 1957 19

FOREST INSECT RESEARCH 21
Spruce Budworm Control 21
Forest Insect Surveys 22
Spruce Budworm Studies 23
Douglas-fir Beetle Studies 25
The Chermes Problem 26
Silver Fir Beetle Studies 27
Plans for Forest Insect Research in 1957 28

FOREST MANAGEMENT RESEARCH 30
Genetics 30
Silvics 32
Seeding and Planting 34
Brush Control 38
Fire Research 42

FOREST MANAGEMENT RESEARCH (Cont'd)
Thinning and Salvage Cutting 44
Growth, Yield, and Stand Characteristics 48
Plans for Forest Management Research in 1957 53

FOREST PRODUCTS UTILIZATION RESEARCH 56
Pulp and Paper 56
Appraisal-Base Study 57
Skyline Crane 57
Degrade Studies 61
Laminating 61
Cost of Hauling Logs 62
Seasoning 62
Performance of House Paints 63
Plans for 1957 64

RANGE MANAGEMENT RESEARCH 65
Management of Livestock Ranges 65
Use of Fire for Range Improvement 68
Effects of Logging on Forage 70
Range Condition and Trend 70
Ecology of Elk Sedge 75
Management of Big-Game Ranges 76
Plans for Research in 1957 79

WATERSHED MANAGEME NT RESEARCH 81
Corvallis Watershed Studies 81
Soil Secrets Studies 82
Effect of Timber Cover on Streamflow 83
Snow Management in Lodgepole Pine 84
Erosion from Grazing 84
Bull Run Watershed Study 85
Plans for 1957 86

AERIAL-SURVEY TECHNIQUES RESEARCH 87
Insect Damage Evaluation 87
Forest Inventory Techniques 89
Plans for Techniques Research in 1957 91

PUBLICATIONS AND ARTICLES, 1956 93

RESEARCH PROVINCE MAP . . . . . .

INTRODUCTION

The forest, range, and watershed problems of the Pacific Northwest are exceedingly varied and complex. Because products of our forest industries are sold in large volume in national and world markets, solution of these problems is important to many people. Douglas-fir, our principal native tree species, was introduced in Europe by David Douglas over a century ago and now it also is an important commercial forest tree in Northern Europe and the British Isles.

Research on forest and related problems is not done in an ivory tower. It requires careful planning to make effective use of available funds and to develop and equip a highly trained staff of technicians. It also involves the assistance and cooperation of many other people. Increased funds were allotted to this Station for the fiscal year commencing July 1, 1956. Appropriately, the Station gave special attention to program planning and personnel during 1956.

A first step in planning a comprehensive research program is to prepare a problem analysis, which is both an appraisal of the major forest, range, and watershed problems within a specified area and a program of research projects directed toward solution of those problems. The problem analysis must be a living document or it soon fails in its purpose, for program planning is a never-ending job. We are constantly revising problem analyses, establishing project priorities, and writing new study plans or amending old ones. So, we do not mean to imply by any means that this task has been completed, nor in fact that we see the end ahead. But during the year we made a special effort to review programs

and plans, to take stock of where we stand, and to orient our program in the most promising and deserving direction.

This and preceding annual reports of the Station report many accomplishments, and it would be reasonable to expect that objectives should be nearer our reach. Then why spend so much time on continuous program planning? The problem analysis supplies the answer. We find new and more complex problems developing as we learn more about the forest, range, and watershed situation; as our use of forest, range and water grows and changes in character; and as nature seeks to resist impacts of man's use or to accommodate itself to this intrusion.

Nature can suddenly produce surprising new developments. We have an example in the recent outbreak of the balsam woolly aphid in southwestern Washington, which is causing great damage. Here is an insect that did not enter our thinking or planning a few years ago. Other examples could be mentioned of similar occurrences; the Port-Orford-cedar root rot for one. These examples illustrate the need for continuous planning and flexibility in our research programs. This should not discourage long-range planning, however, for we are just now providing answers to problems that were anticipated a generation or more ago by a few imaginative foresters, who initiated many of our research programs.

Some major problems are so compelling they can be foreseen clearly. Take the problem of artificial regeneration of our forest stands in all its complex phases. We are now planting in the Pacific Northwest 75,000 acres a year at an estimated cost of 2-1/4 million dollars. In contrast we are clear cutting over 300,000 acres a year. While much of this area will regenerate naturally, we must step up our planting program if we are to meet future timber needs and keep our lands productive. It is estimated that there is a backlog of old cutovers and burns in the region totaling over

2-1/2 million acres that need planting, either fill-in or complete.

Best direction of this impressive and costly effort depends on having all the facts concerning the related physical and economic conditions. It means obtaining answers to many unsolved problems: selection of genetically superior parents for these future trees; the relationships of soils and climate in which the trees will grow; impact of their vegetative associates, friendly or inimical; effects of insects, other animals, and diseases that may attack the cones, seeds, nursery seedlings, or the planted trees; and a host of other pertinent factors. Aggravating this biological complex are hard economic problems that may spell the difference between a successful enterprise or failure that cannot be overcome without additional information.

In the early days of forest research in this region there was a vast unexplored area. Separate disciplines--silviculture, entomology, pathology, animal biology, and so on--could more or less go their own ways without seriously involving other studies. Now we must use a task-force approach, searching to solve the whole problem. Natural regeneration provides an example of the ramifications involved in solving a major problem with an apparently simple objective. The real challenge, however, lies in providing the information needed to answer all the problems that will develop in practicing multiple-use management. It means learning how plants, soil, water, animals, and economic man can live together in harmony and full productiveness.

Anticipation that the time is near when multiple-use management in some degree will be the universal policy of most forest landowners, public and private, is the major reason we must intensify and broaden our efforts in program planning. Like a jigsaw puzzle, some of the pieces are easy to fit, others are more difficult. Identifying the obscure but key pieces is the difficult part of the problem analysis.

Planning is equally important in recruiting and maintaining a technical staff. The general shortage of trained scientists and technicians in all fields of research is a well-publicized problem. The Station has had its share of this problem. We are endeavoring to answer it, at least in part, by giving added impetus to training of the present staff, both on the job and in formal graduate study at appropriate institutions. As another means of facilitating our technical staff, we are strengthening the specialized services--statistical, editorial, and library.

In furthering our objectives, we have been assisted by cooperation received from many sources. They include national forest administration; other public agencies, both Federal and State; educational institutions; and many private companies, associations, and individuals. The counsel of our Station and research center advisory committees is particularly helpful.

We have made good progress in the past year toward immediate and longtime objectives. Many tangible accomplishments are reported in the various fields of study conducted by the Station. More important, we are getting started in relatively new fields that are fundamental to our major objective. New work was started in watershed management, in game-range relationships, in artificial regeneration, and in forest economics. Details of our progress and plans follow. We invite comments on both.

FOREST DISEASE RESEARCH

For many years this Division has been the only organization working on forest diseases in the Pacific Northwest. Even with the helpful cooperation of other public and private forestry groups, it has been impossible to give many of our urgent problems the attention they should have. The situation is changing for the better.

Both State agencies and private industry are now undertaking research in this field, and the large losses reported in the Timber Resource Review should stimulate further interest. These additional efforts, together with the advantages of cooperative approach and the introduction of more varied viewpoints on difficult problems, will unquestionably hasten progress in forest disease control.

NURSERY AND PLANTATION DISEASES

Fusarium Root Rot of Ponderosa Pine

Large-scale tests in the Bend (Oregon) nursery have substantiated previous research findings that losses can be reduced, without impairing formation of mycorrhizae, by addition of sawdust and ammonium phosphate to acidified soil. Also, fall-sown seedlings were found to be less susceptible to Fusarium root rot than those sown in late spring, but were more subject to frost damage. The spotty occurrence of root rot, and its greater severity after dry springs, indicate that it is greatly affected by soil moisture conditions. Further work in this field offers promise of better means of control.

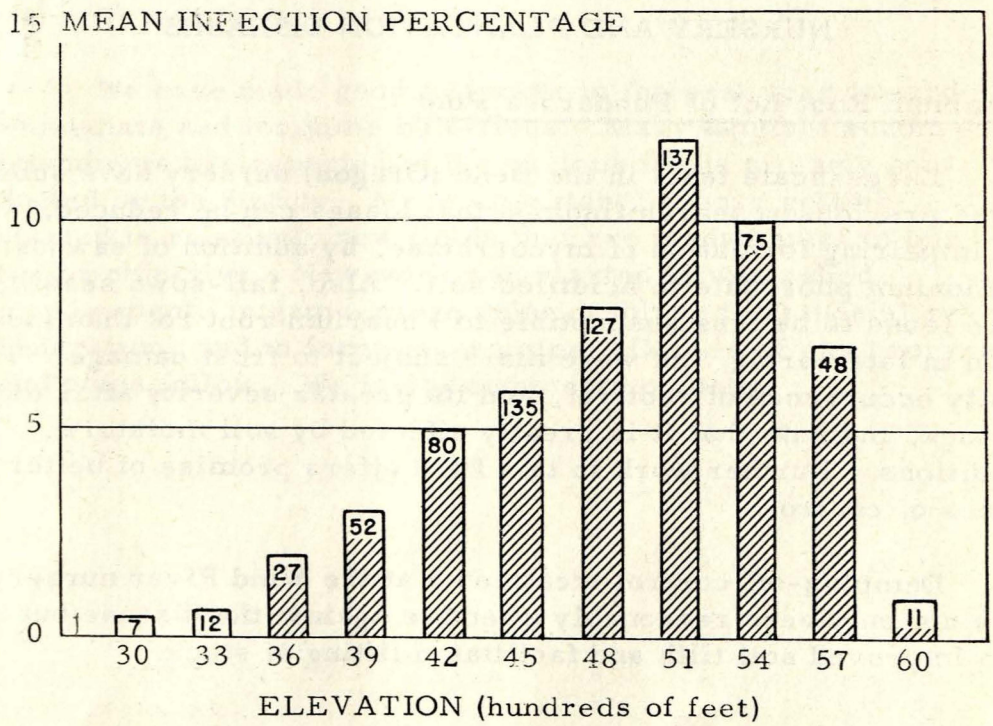
Damping-off control treatments at the Wind River nursery have not only been reasonably effective against the disease but have also improved soil tilth and facilitated lifting of stock.

FOLIAGE DISEASES

Needle Blight of Ponderosa Pine

Infection throughout the region was generally about the same as in 1955. No new centers were found, and no appreciable increase of infection was observed in old centers. Surveys in central and eastern Oregon, where the disease has been most active during the past 12 years, showed that only about 1 percent of the ponderosa pine type is infected heavily enough to result in killing of mature trees. However, the disease is reducing the vigor and thereby increasing the mortality risk of numerous trees on about 10 percent of the pine acreage. Most of the heavily infected timber in the oldest and worst infection centers has been salvaged.

Survey data indicate that the disease is most severe at elevations around 5000 feet; at both higher and lower elevations, infection is usually much less severe. No relationships were found between infection and aspect, forest type, or topography.



Infection of ponderosa pine by needle blight varies with elevation. Number inside each bar indicates number of sample plots taken.

STEM DISEASES AND DECAYS

White Pine Blister Rust

In nursery beds of sugar pine exposed to both natural infection and artificial inoculation, infection was reduced about 50 percent by spraying with a ferric dimethyl compound.

Several rust-free western white pines of good form and vigor were found during intensive examinations of heavily infected plantations and natural stands in western Washington and western Oregon. If the apparent rust resistance of these trees is confirmed by inoculations, they will be used as parent stock in breeding projects. On many areas at moderately high elevations in this region, western white pine will produce more volume than any other species but cannot be grown economically at present because ribes eradication is too expensive.

Decay of Beetle-Killed Timber

Preliminary studies in west-side stands indicate that decay of beetle-killed Douglas-fir and Pacific silver fir can be materially retarded by felling the trees and leaving them unbucked in heavy shade. Decay is slowest in the basal third of the bole, where the thicker bark also helps to prevent drying. If the felled trees are bucked and exposed to sun and wind they decay about as rapidly as if they had been left standing.

Decay of Windthrown Douglas-fir

Decay of windthrown trees appears to be more variable, but generally less rapid, than is decay of standing beetle-killed trees. There is also less breakage in windthrown trees than in felled beetle-killed trees on similar ground.

Heart Rot in Lodgepole Pine

Preliminary field work indicates that fire scars are important entrance courts for butt rots and some trunk rots. Stem cankers caused by Peridermium gall rust frequently serve as infection courts for trunk rots. A red rot, probably caused by Polyporus circinatus, often results in cull of the entire tree.

Heart Rot in Ponderosa Pine

This species is generally sound in this region, but at least three fungi cause extensive heart rot in occasional stands. One of these fungi appears to be important only in old trees on poor sites, but the other two may be able to damage young sawtimber on good sites. External indicators of decay are not common enough to be of much use in estimating defect in standing timber.

ROOT DISEASES

Poria Weirii Root Rot of Douglas-fir

Western hemlock often succeeds Douglas-fir in centers of Poria infection, and usually remains free from the disease for many years. Its survival to commercial maturity under such circumstances has been open to some question, since most of the evidences of root-rot infection in the preceding stand usually disappear in less time than that required for hemlock to attain sawtimber size. During the year, data were obtained from a stand where sawtimber-size hemlock had suffered only negligible damage although root rot had been and was continuing to be destructive to adjacent and intermingled Douglas-fir. This is not conclusive evidence, but it considerably strengthens the probability that hemlock can profitably be substituted for Douglas-fir on good hemlock sites where Douglas-fir productivity is seriously reduced by root rot.

Armillaria Root Rot in Residual Stands

Damage by this disease has not been considered serious in this region, but in one ponderosa pine stand the fungus was recently found to have caused an appreciable reduction in stocking of saplings and poles over an area of more than 2,000 acres. In other stands, stocking of saplings has been reduced over smaller areas. Distribution of the damage, together with evidence from other sources, suggests that spread of the disease may have been stimulated by partial cutting. Further investigations are necessary to determine the extent to which damage by this root rot may be affected by cutting practices, not only in ponderosa pine but also in other forest types.

Polyporus Circinatus Root Rot of Ponderosa Pine

This fungus has occasionally been found in both the Douglas-fir and ponderosa pine subregions, but it has not previously been considered of much significance here even though it is known to cause a destructive root and butt rot in some other parts of the world. During the past year it was identified as the cause of an extensive root rot as well as trunk rot in ponderosa pines in three localities. In one locality it appeared to have caused considerable mortality in mature ponderosa pine. Unlike Fomes annosus and Armillaria mellea, which are common killers of young pine, Polyporus circinatus appears to have little if any effect on seedlings and saplings.

Phytophthora Root Disease of Port-Orford-cedar

No extension of this disease was found within the native range of its host during the 1956 survey.

DECAYS AND STAINS OF FOREST PRODUCTS

Retardation of Decay in Stored Logs

Sprinkling of cold-decked western hemlock logs in warm weather retarded decay even more during the second year than during the first year of storage. This was true for logs that contained decay at the start of the test as well as for those that were originally sound. Green logs stored in a sprinkled cold-deck were about 6 percent decayed (typical and incipient) at the end of the first year and were less than 7 percent decayed at the end of the second year. Corresponding percentages in the unsprinkled cold-deck were 8 and 25,

Sprinkling during warm weather retarded decay in this western hemlock cold deck. Note standard agricultural sprinkler on top of deck.

respectively. Reduction of internal log temperatures by sprinkling did not appear to be as important in limiting decay as was the moisture content of the wood.

On-the-job Treating Tests

Decay is now well established in untreated flooring and rail units exposed for 4 years to outdoor conditions. Lenzites saepiaria is fruiting on some of the flooring units.

DISEASES NOT OF PROJECT STATUS

Winter Injury

The "deep freeze" of November 1955 injured both softwood and hardwood trees, especially reproduction, in northwestern Oregon and western Washington. Douglas-fir and western hemlock suffered some defoliation even in closed stands, and occasional exposed trees were almost completely defoliated. In some localities, patches or strips of western hemlock cambium were killed. Many leaders were killed back in stands of reproduction, and others were weakened enough to be subsequently attacked and killed by weakly parasitic fungi. Except over small areas in a few localities, practically all of the injured trees appear to be recovering, and total damage will probably be slight.

Root Rot of Bitterbrush

Extensive dying of this important browse plant in one locality was found to be caused by Armillaria mellea, a common and sometimes damaging root rot of forest trees and many other plants. This disease is difficult to identify on this host in the field, since sporophores are produced only when conditions are exceptionally favorable and since they persist for only a few weeks at most. The same pattern of killing, however, has been observed in several other localities, and it is possible that Armillaria is responsible for much of the damage to bitterbrush that has recently occurred in this region.

Rhododendron Rust of Spruce

A European rust new to this country, Chrysomyxa ledi var. rhododendri, was found by nursery inspectors in 1954 on several varieties of nursery-grown rhododendrons in southwestern

Washington. No infections have been found on native rhododendrons, and nurserymen are apparently succeeding in efforts to eradicate the disease. In its European home, this rust causes defoliation of spruce, but the susceptibility of Sitka spruce to it is not yet known. Teliospores, necessary for infection of spruce, have not been produced by the fungus thus far in this region.

COOPERATION

A number of organizations, both private and public, helped the division with 1956 projects. Substantial contributions were made by the following: Biles-Coleman Lumber Company, Crown Zellerbach Corporation, J. Neils Lumber Company, Oregon Pulp and Paper Company, Pilot Rock Lumber Company, Weyerhaeuser Timber Company, Oregon State Board of Forestry, Oregon State Department of Agriculture, Washington State Department of Agriculture, and Washington State Division of Forestry.

PLANS FOR FOREST DISEASE RESEARCH IN 1957

1. Continue nursery and plantation disease studies, with increased emphasis on factors affecting establishment and survival.

2. Continue studies of damage by ponderosa pine needle blight, but make no further surveys unless new outbreaks occur.

3. Develop methods for dwarfmistletoe surveys, and especially for appraisal of damage by these parasites. Initiate small-scale tests of silvicultural control measures as opportunities arise.

4. Continue studies of decay of killed timber as dated dead trees become available to fill the gaps in our present data.

5. Obtain additional data on heart rots of ponderosa pine, lodgepole pine, and alder, to determine the extent to which large-scale investigations may be necessary.

6. Start an investigation of relationship between stand density and damage by Poria weirii, and make preliminary studies of Polyporus circinatus root rot in ponderosa pine and of Armillaria mellea in residual stands.

7. Devote additional efforts to diseases not now of project status, but likely to require intensive study within the next few years.

8. Develop a white pine blister rust research program to provide information needed in control activities.

FOREST ECONOMICS RESEARCH

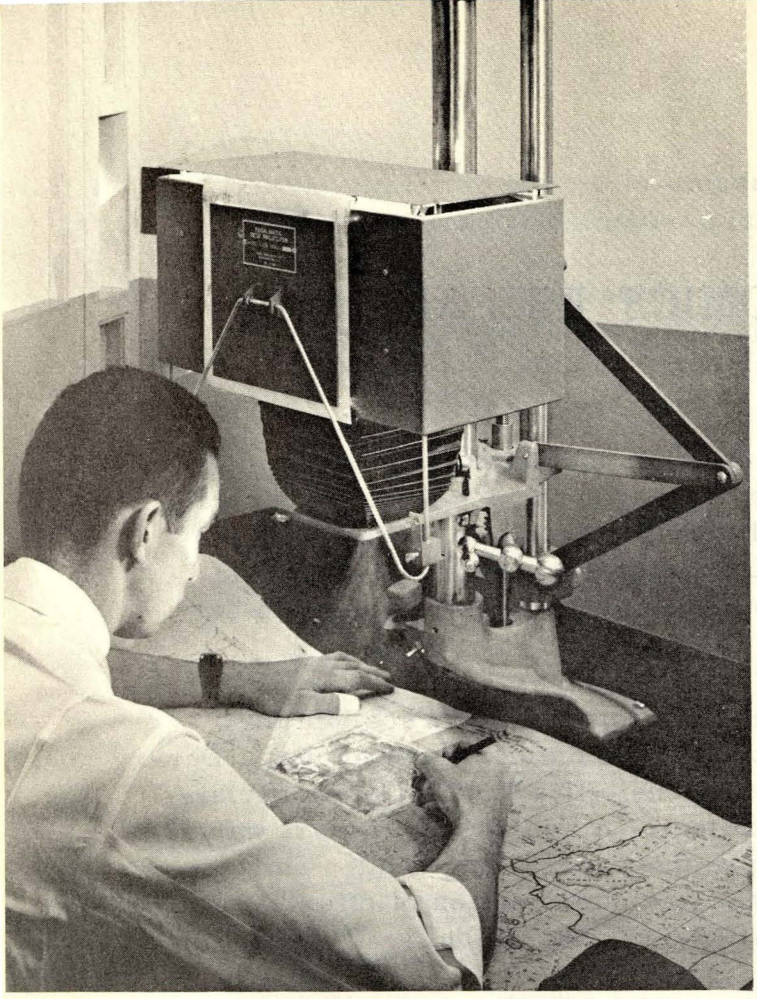
The work program of the division has assumed a better balance in recent years. Forest Survey continues in the dominant role assumed at its beginning almost 25 years ago. Continuing progress can be reported on joint forest-survey--working-circle inventories. And research in other fields of forest economics has rapidly come into the picture.

In 1955, for the first time, an allotment was received for general studies in forest economics. This work is continuing. During 1956 the division was given responsibility for part of an aerial-photo-interpretation research project. Also in 1956, a start was made on research in the forest products marketing field. This start involved formulation of plans and coordination of efforts with other research groups in similar and related fields.

FOREST SURVEY PROGRESS

In July 1946, after a period of several years during which normal survey activities had been curtailed by the war effort, Forest Survey started a new program of the reinventory of the forest resources of Oregon and Washington. By the end of 1956, field work had been completed on 64 percent of the total forest area in the region. At this rate of accomplishment the inventory period required to cover the 54,129,000 acres of forest land in the Northwest would be 16 to 17 years.

However, the rate of accomplishment has not been constant over the entire period. Using more recent experience as being more representative of current progress, a total of 17,396,000 acres has been inventoried over the 4-year period from December 1952 to the present. At this rate the reinventory would require 12 to 13 years. Shortening the reinventory cycle is essential to keep abreast of rapidly changing conditions in the forest situation.



Preparation of type maps from aerial photographs is an important part of Forest Survey's work.

OBSERVATIONS BASED ON RECENTLY REINVENTORIED COUNTIES

Since early 1952, 8 counties have been reinventoried in the Douglas-fir subregion. These are Hood River, Columbia, Lincoln, Tillamook, and Clatsop Counties in Oregon; and Snohomish, Thurston, and Lewis Counties in Washington. During the same period the following 10 counties were covered in the ponderosa pine subregion: Deschutes, Harney, Wheeler, Jefferson, Crook, Morrow, and Wasco Counties, Oregon; and Klickitat, Kittitas and Yakima Counties, Washington. In these 18 counties, some interesting developments have occurred with regard to ownership, stand-size class, and species of sawtimber.

Ownership

For this 18-county total, State ownership has increased in the past 25 years. Largely as a result of tax delinquency following the Tillamook Burn in Oregon in 1933, State ownership in Tillamook

County jumped from 1,000 to 308,000 acres between 1934 and 1955. A similar event, the Wolf Creek fire, increased State lands in Clatsop County, Oreg., by 140,000 acres in the same period. Other substantial increases occurred in Lincoln County, Oreg., and Thurston and Snohomish Counties, Wash. Forest land in county ownership increased in the early thirties during a period of tax delinquency. It has now returned almost wholly to private or State ownership.

In general, Federal ownership of productive forest land[1/] has stayed fairly constant in these counties from the early 1930's until the present. During this period the percentage in Federal ownership increased from 25.9 to 27.4 in the 8 Douglas-fir subregion counties and from 62.4 to 67.8 in the 10 ponderosa pine subregion counties. Most of the increases occurred through exchanges of private land for timber prior to 1952. In Crook County, Oreg., the productive forest land in national-forest ownership has increased about 59,000 acres and in Kittitas County, Wash., about 67,000 acres. Land managed by the Bureau of Land Management has been reduced about 172,000 acres; one-third in the Douglas-fir counties and two-thirds in the ponderosa pine counties.

Private acquisitions of forest land in several counties have been offset by major decreases in other counties such as Tillamook, Clatsop, and Snohomish.

Stand-size Class

Changes in stand-size class result from many factors, including logging practices, fire occurrence, level of management, and the passing of time. Area changes within the productive forestland area are noticeable, particularly in extent of poletimber stands.

Since the early 1930's the area of poletimber has doubled in both the Douglas-fir and ponderosa pine subregion counties. In Thurston County there has been an increase of 150,000 acres and in Columbia County, 70,000 acres. The total increase for the 18 counties has been 934,000 acres. Area of seedling and sapling stands and nonstocked lands has decreased as better management

---

1/ Productive forest land includes commercial forest land available for production of wood products and similar lands in areas where cutting is prohibited.

practices and fire-control methods have allowed these areas to move into other classes. The decrease in the 8 west-side counties totaled 678,000 acres and in the 10 east-side counties, 595,000 acres.

In general, the acreage in sawtimber has remained relatively unchanged. However, these stands now have a higher proportion of young trees, some of which advanced from poletimber, while others--especially on the east side,--were left in partially cut stands. In the early 1930's, 94 percent of the sawtimber stands in the 10 east-side counties were uncut; recent inventories show a decrease to 69 percent.

Species of Sawtimber

Log production statistics show that timber harvesting has generally favored the removal of Douglas-fir from stands west of the Cascade Range and of ponderosa pine east of these mountains. This practice is reflected in changes in species composition of the remaining sawtimber. In the original inventory of the 8 west-side counties, Douglas-fir comprised 54 percent of the sawtimber volume on available commercial forest land, whereas recent reinventories show about 46 percent of the volume is in this species. Complementing this change, the proportion of hemlock in the same area increased from 24 to 32 percent. In the original inventory of the 10 east-side counties, ponderosa pine comprised 56 percent of the total volume while recent reinventories of the same counties show the pine volume to be 47 percent of the total. As the proportion of pine decreased, Douglas-fir increased from 20 to 24 percent and the true firs from 10 to 13 percent of the total volume.

JOINT WORKING CIRCLE-FOREST SURVEY INVENTORIES

During the year, joint efforts of forest-survey and national-forest personnel in Oregon resulted in the reinventory of approximately 2.3 million acres of national-forest land, covering all of 8 working circles and parts of 2 others. In addition, Forest Survey inventoried approximately 1.5 million acres in other ownerships, primarily in Lane and Baker Counties.

Working circles in this joint effort in western Oregon were the Oakridge and McKenzie Bridge on the Willamette National Forest, the Cottage Grove and a part of the North Umpqua on the Umpqua National Forest, and the Mapleton and a part of the Waldport on the

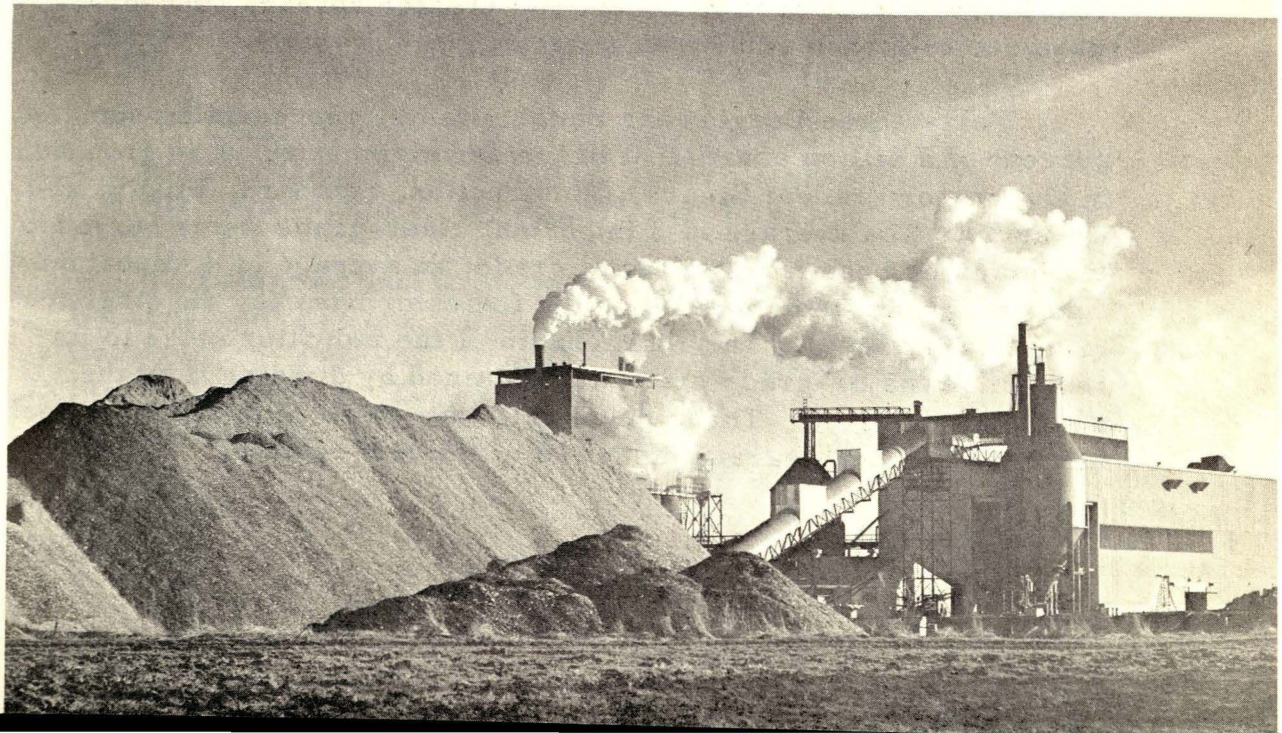
Siuslaw. In eastern Oregon the Pine, Union, Burnt River, and Elkhorn Working Circles on the Wallowa-Whitman National Forest were inventoried.

Work of national-forest personnel supplemented Forest Survey's regular sample-plot program in these working circles. The additional sample plots, together with the Forest Survey plots and type-map information, supply the national forests with inventory data needed for management planning and the recalculation of allowable annual cuts. The additional sample plots also provide Forest Survey with more accurate information on timber volume, growth, and mortality than can ordinarily be obtained through the regular intensity of sampling.

SUPPORTING STUDIES IN LANE COUNTY

In connection with a Forest Survey reinventory of the forests of Lane County, Oreg., a supplemental project is being financed cooperatively by the station and the Lane County Chamber of Commerce. Objective of the project is to obtain information on the present and prospective character of the forest resources and their utilization to supplement the usual forest-area and timber-volume statistics provided by Forest Survey. A number of related studies

Symbolic of integration between the pulp and sawmill industries, this huge pile of wood chips was derived from sawmill residues. Chips from residues are an important source of raw material for Pacific Northwest pulp mills.



are being made, including the following: survey of existing forest industries; determination of annual volume and source of raw wood consumed by these industries; determination of annual volume of timber cut, by landownership source; survey of unutilized salvable wood made available annually on logged areas; survey of plant residues developed annually by sawmills, veneer and plywood plants, and other primary and secondary manufacturing plants; analysis of industrial employment, payrolls, and volume of manufactured forest products; study of the forest landownership pattern; estimation of rate of net annual forest growth; and analysis of opportunities for maintaining or expanding forest industries in the county.

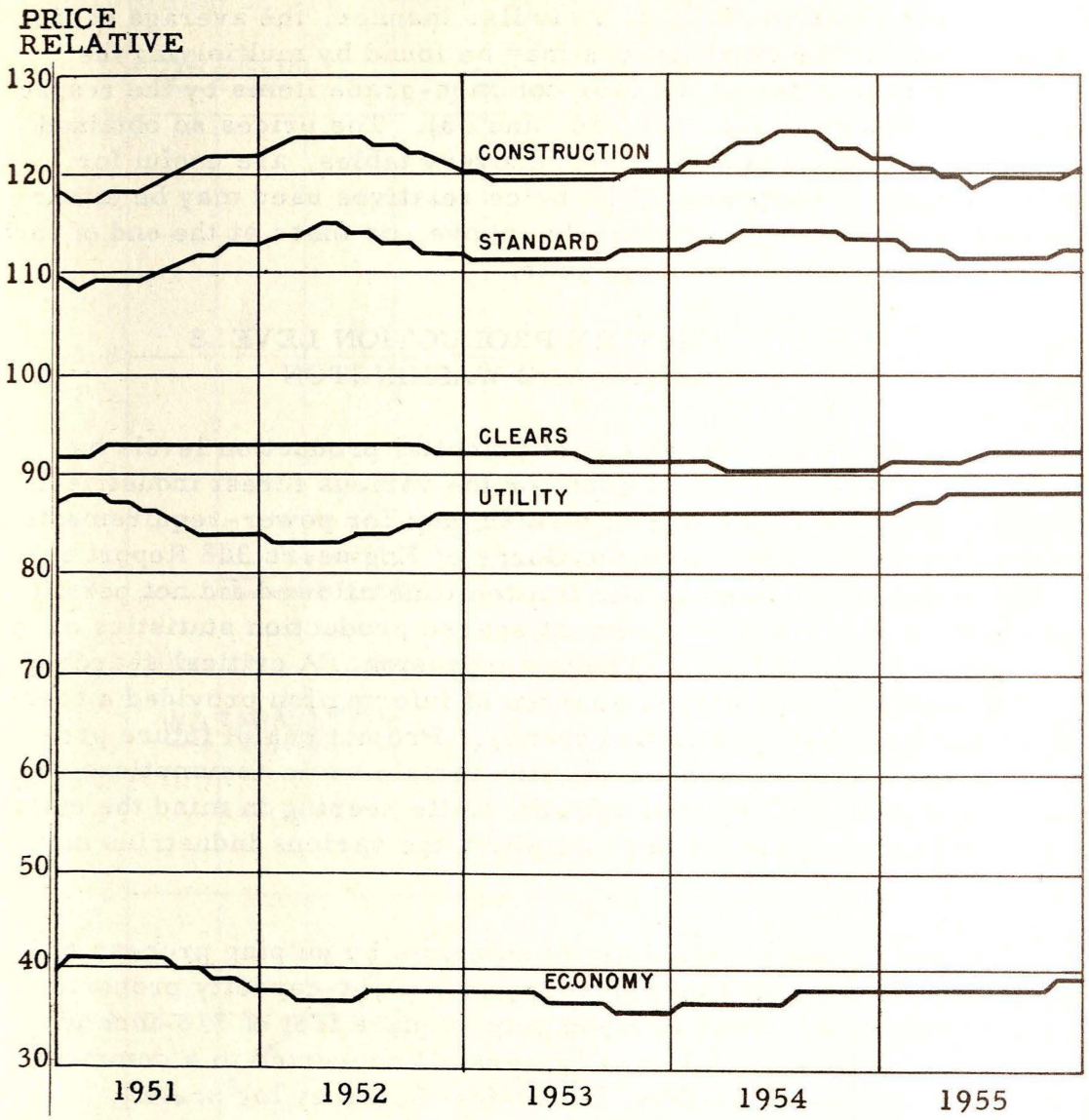
Following completion of field work, office computation, and analysis of data from the reinventory and supplemental studies, a comprehensive report will be prepared.

LUMBER PRICE TRENDS AND RELATIONSHIPS

An analysis was made of average prices (Western Pine Association index) for ponderosa pine from 1936 through 1955. Monthly price data were tested for seasonal effect over the entire 20-year period and separately by the following 5-year periods: 1936-40, 1941-45, 1946-50, and 1951-55. Season had no significant effect on prices during any period. There was a highly significant rising trend during the periods 1941-45 and 1946-50, but not during the 1936-40 and 1951-55 periods. Although prices tended to be higher in the spring and lower in the fall and winter, the difference was too small to consider and the pattern was not consistent. Over the 20-year period, spring prices averaged less than 1 percent above the moving annual average prices; fall prices averaged less than 1 percent below. Individual years showed greater spreads, but these were due to forces other than seasonal.

Forty-three Douglas-fir lumber items, representing some 80 percent of 2 billion board-feet of lumber shipments, were grouped in five major grades: Clears, Construction, Standard, Utility, and Economy. The average of 2 important clear-grade items served as the indicator base for the Clears grade; an average of 4 important common-grade items served as the indicator base for the other four grades (Commons). The relationship of the indicator price to its respective major-grade price was obtained by dividing it by the major-grade price. These price relatives were computed at 4-week intervals for five years and showed consistent results.

Douglas-fir lumber price relatives,
by major grades at 4-week intervals



Clears Indicator Base is average price of:

1. C & Btr: Flooring, 1x4, RL, Flat or mixed grain, dry
2. C & Btr: Drop siding, 1x6, RL, Flat or mixed grain, dry

Commons Indicator Base is average price of:

1. Construction: 25% Std., Dimension, 2x4, RL, S4S, green
2. Construction: 25% Std., Boards, 1x8, RL, S4S, green
3. Utility: Dimension, 2x4, RL, S4S, green
4. Utility: Boards, 1x8, RL, S4S, green

Average selling price of the Clears grade is found by multiplying the current average price of the two clear-grade items by the Clears price relative (91). In a similar manner, the average selling price of each of the other grades may be found by multiplying the current average price of the four common-grade items by the respective price relatives (121, 111, 86, and 38). The prices so obtained, in conjunction with lumber-grade recovery tables, are useful for timber appraisal purposes. The price relatives used may be either the long-term average, as indicated above, or those at the end of each year for use during the ensuing year.

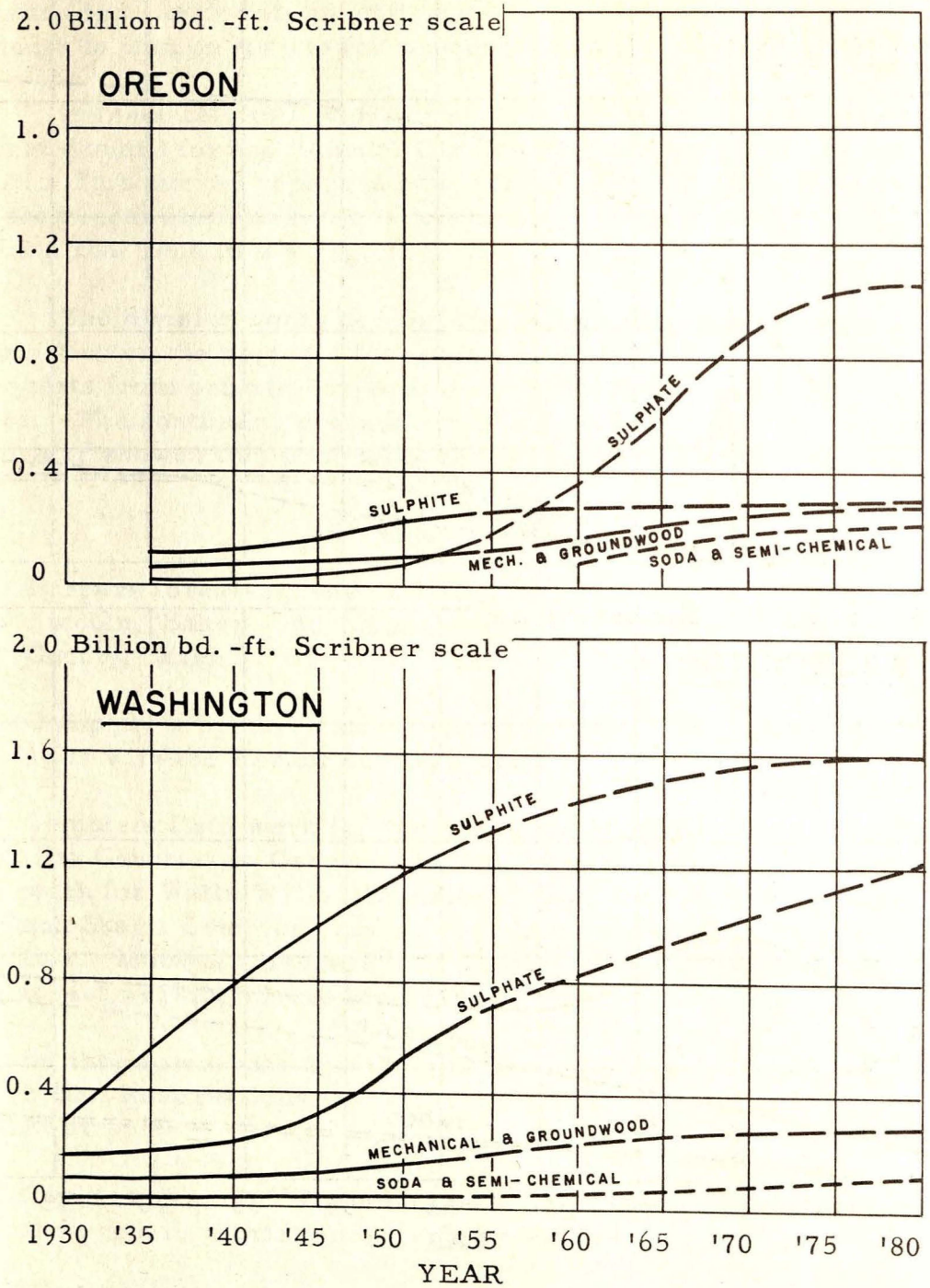
FOREST INDUSTRY PRODUCTION LEVELS IN OREGON AND WASHINGTON

An analysis has been made of potential production levels by 1960, 1965, 1970, 1975, and 1980 for the various forest industries. Purpose of this analysis was to furnish data for power-requirements projections in the revision of the Corps of Engineers 308 Report on the Columbia River Basin. The limited time allowed did not permit making field surveys to supplement sparse production statistics or to sample opinion as to future industry expansion. A critical search of all published and unpublished sources of information provided a basis for establishing past production trends. Projections of future production were made in accordance with certain basic assumptions regarding national and regional growth, while keeping in mind the existing and potential resource base on which the various industries must depend.

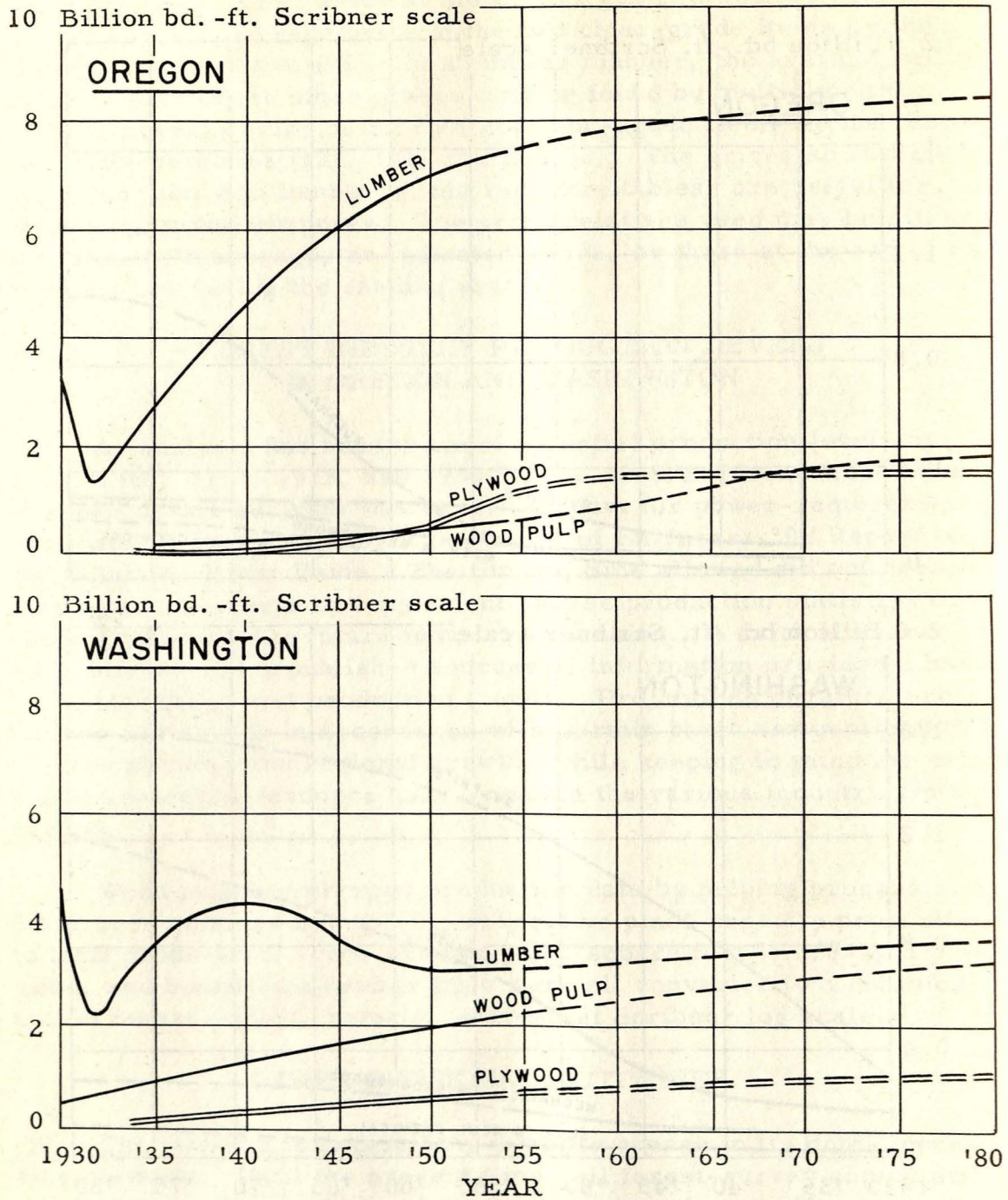
Wood pulp and plywood production data by pulping process and State were obtained by applying respective plant-capacity proportions to total production. Tons of wood pulp, square feet of 3/8-inch plywood, and board-feet lumber tally were all converted to a common unit of measurement, namely, board-feet Scribner log scale.

OTHER DIVISIONAL ACTIVITIES

The division is undertaking a major change in its data-processing methods. Until the present time, all forest-survey computations, tabulations, and summaries have been prepared manually on forms and spread sheets. When machine computation first became a possibility, the division seriously considered changing over. However, initial cost for converting to this program appeared high in view of the volume of work. Subsequently, the electronic computer entered



Past and projected production trends of wood pulp, by pulping process, in Oregon and Washington.



Past and projected production trends of major wood-products industries in Oregon and Washington.

the picture and its application to survey work became apparent. The station has carried its investigation of the electronic machine far enough to plan on its use for processing data to be collected in 1957.

Immediately following its release in September, there was a great demand for the "Annual Cut and Timber Products Output" report. This survey report is based largely on 1952 data, with some more recent statistics. It is one of a series of periodic studies and fills a real need in the region.

The division continued to furnish statistical and analytical information on the region's forest resource in response to numerous requests from private corporations, individuals, and public agencies. The continuing demand for county forest-type maps during the year showed this product of forest survey to be still popular.

PLANS FOR 1957

1. Prepare forest-survey statistical reports for Wasco, Tillamook, Lincoln, Baker, and Lane Counties in Oregon; and for Snohomish County, Wash.

2. Complete a special Lane County analysis, and incorporate results with the Forest Survey report.

3. Complete field work for the survey of Wallowa, Union, and Umatilla Counties in Oregon. In Washington, complete survey field work for Walla Walla, Columbia, Garfield, Asotin, Whatcom, and Skagit Counties, and minor parts of Pierce and King Counties. Much of this work will be in connection with national-forest working circle inventories.

4. Initiate a two-year inventory program of the Colville and Spokane Indian Reservations in cooperation with the Bureau of Indian Affairs.

5. Complete a policy statement covering forest-economics research and prepare a marketing project analysis.

6. Assist in completion of the first phase of a marketing study begun at Oregon State College. Initiate new marketing studies.

WM 31

7. Prepare for publication, (1) data on lumber price relationships, including seasonal variations, and (2) estimates of industry expansion.

8. Prepare a plan on techniques for studies of private forest land-ownership in the Pacific Northwest.

9. Study the marketing pattern displayed by national-forest timber sales.

10. Prepare a report on forest resources of the Douglas-fir subregion.

11. Continue to assist Washington Office in preparation of a price trends and relationships report.

12. Make plans for preparation of an inter-divisional handbook of northwest hardwoods.

FOREST INSECT RESEARCH

The year was marked by suspension of aerial spraying against the spruce budworm for the first time in 7 years. Although few of the region's destructive insects were seriously epidemic, Chermes was an exception, being widely destructive in true-fir stands.

The station, working with numerous cooperators, continued its efforts to solve regional insect problems on a priority basis. Survey information was obtained and distributed to timber owners and forest agencies to aid in the general effort to keep insect-caused losses minimum.

SPRUCE BUDWORM CONTROL

The spruce budworm epidemic that began in 1944 is still in progress, but is less extensive than at any time since 1946. Timely, cooperative aerial spraying of 3.8 million acres from 1949 through 1955 averted mass killing of timber by the budworm. Accomplishments of the 7-year control program were reviewed at the Tenth International Congress of Entomology and also were issued as a station report.

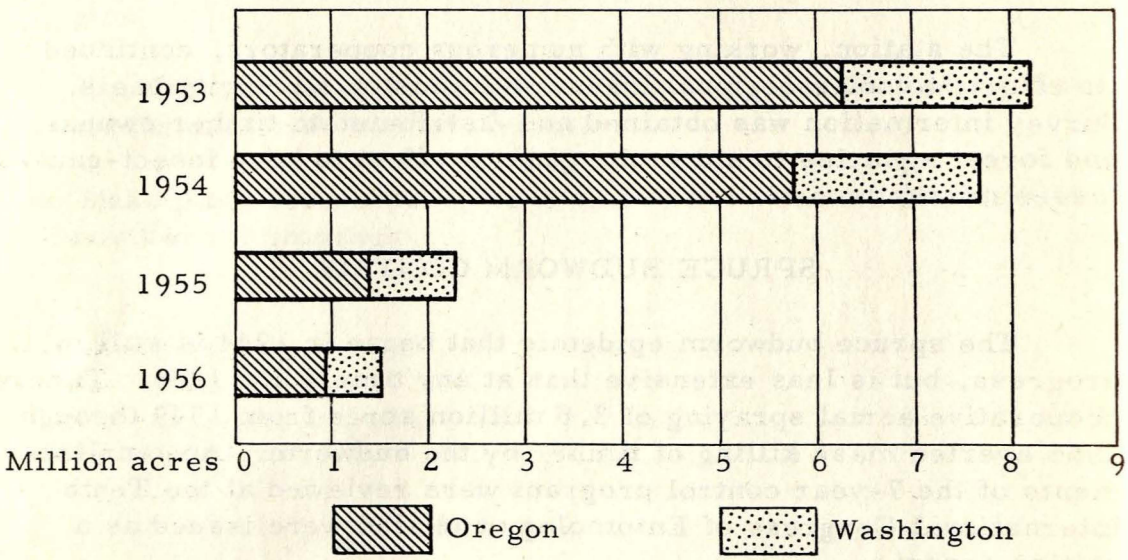
Upon recommendation of the Northwest Forest Pest Action Council in the fall of 1955, spraying was suspended, even though 542,430 acres of epidemic infestation remained. The recommendation was based on a combination of survey and research findings that showed a reduced threat of tree killing and a marked increase in effectiveness of natural control.

In the fall of 1956 the Pest Action Council recommended that no spraying be done in 1957, but alerted timber owners and administrative agencies that control might become necessary on some areas in 1958. Epidemic infestations now total 536,120 acres, all in eastern Oregon. Generally the budworm population is declining, except in the central Blue Mountains in the vicinity of Granite, where the trend is upward.

FOREST INSECT SURVEYS

Status of Infestations

Cooperative surveys of the 45 million acres of commercial forest land in Oregon and Washington showed a marked reduction of insect outbreaks for the third successive year. In 1956 only 1,542,320 acres of epidemic infestation were mapped, as compared with 2,248,820 acres in 1955, 7,704,120 acres in 1954, and 8,196,320 acres in 1953.



Insect outbreaks in Oregon and Washington declined for the third successive year.

Epidemic infestations of the spruce budworm covered slightly less acreage than in 1955. In most of the outbreak centers, current damage by the budworm was classified as "light." However, in the central Blue Mountains area of Oregon, defoliation by the budworm increased both in area and extent. Douglas-fir beetle populations were low, except on the Colville Indian Reservation where extensive killing persisted in an area that has suffered heavy losses since 1954. Western pine beetle losses were the lowest on record and the outbreak of silver fir beetles in northwestern Washington subsided. Partially offsetting these favorable trends, the killing of Pacific silver fir and subalpine fir by the balsam woolly aphid became more severe and covered more area. This aphid is now the major insect pest problem in the Northwest.

Survey findings were presented at the annual meeting of the Northwest Forest Pest Action Council in October. As in the past, these data were the basis for the Council's control recommendations.

Improvement of Survey Methods

Development of better methods for insect surveys continued as a major activity of the Division of Forest Insect Research. Accomplishments are recorded in the section on Aerial-Survey Techniques Research.

SPRUCE BUDWORM STUDIES

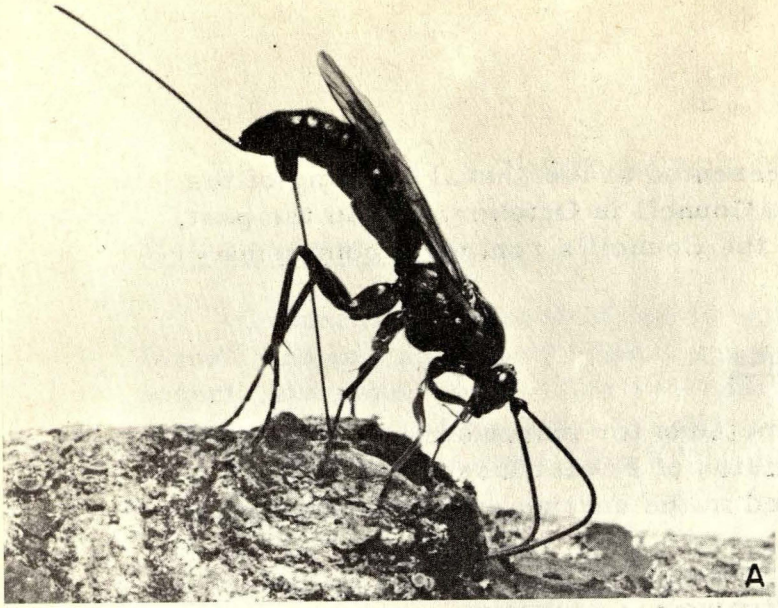
Long-term studies of natural causes of the rise and fall of budworm outbreaks were continued. Major efforts were made to determine: (1) Outbreak trends, (2) nature and rate of spread, (3) effects of parasites and other natural control factors, and (4) accuracy and efficiency of sampling units and methods.

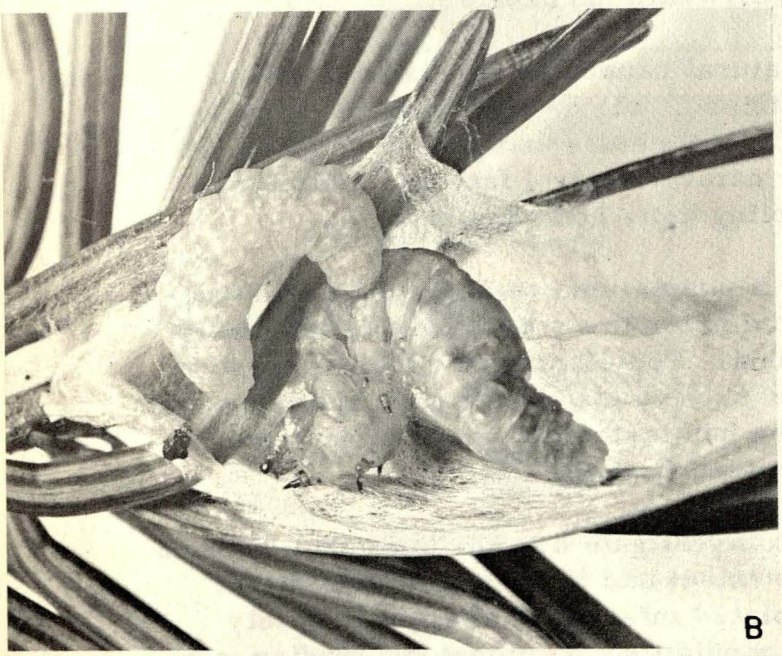
During the year budworm populations on unsprayed areas decreased in infestations detected prior to 1954 and increased somewhat in more recent infestations. Populations on areas sprayed in 1949 and 1950 continued at low to very low densities. Thus, protection resulting from spraying has lasted six years in eastern Oregon and seven years in western Oregon.

A study begun in 1955 to investigate how the budworm spreads showed only minor changes in extent and intensity of infestation. The study area harbors an isolated infestation of approximately 10,000 acres, with moderate populations on ridgetops grading into light populations on northerly slopes. Apparently population pressure was not sufficient to force extensive dispersion.

Natural control was extremely important in 1956. Aggregate parasitism of the budworm from the egg through the pupal stage exceeded 60 percent on three of four study areas. On one study area, mortality of hibernating larvae alone ranged from 26 to 36 percent, with mortality chiefly caused by predaceous insects and mites.

Statistical analysis of populations of small budworm larvae showed a 15-inch twig to be a more efficient sampling unit than the





Natural control of spruce budworm is carrying on from where spraying left off. A, Glypta parasite laying egg in small budworm larva hibernating under bark scale. B, Phytodietus larva (left) consuming large budworm larva.

whole branch, being two to three times more economical in terms of manpower. The 15-inch unit was used to determine manpower needed to evaluate natural control of small populations of the budworm.

DOUGLAS-FIR BEETLE STUDIES

Cooperative research on the Douglas-fir beetle was continued by the station, Oregon State College, and the research departments of the Oregon State Board of Forestry and Weyerhaeuser Timber Company. Because of the general decline of the outbreak in recent years, current studies are to determine the behavior of the beetle under endemic, rather than epidemic conditions.

In 1956 the station initiated a study of the relationship of tree killing by the Douglas-fir beetle to amount and location of windthrown timber. Preliminary assessment of the data shows strong correlations. In all situations studied, windthrow was followed by beetle-killing, although in many instances the killing occurred a half mile or more from the windthrow. The beetle showed a tendency to work progressively up-slope from windthrow, which prevalently occurred on the lee side of ridges and on wet bottoms and benches. Killing by the beetle also was frequently associated with blowdown in stands heavily infected with Poria weirii root rot. These findings substantiate the importance of prompt salvage of Douglas-fir blowdown to lessen attacks by the Douglas-fir beetle.

A study begun in 1955 to determine whether the Douglas-fir beetle breeds successfully in slash on clear-cut areas was replicated in 1956. Findings were essentially the same although climatic conditions during the two growing seasons were quite different; 1955 was generally wetter and colder and 1956 warmer and drier than normal. Relatively little of the slash was attacked; that which was, generally dried out before the beetle broods could mature. Exceptions were large cull logs heavily shaded by debris and slash near shaded edges of clear-cut areas. The few broods that seemed to be developing successfully were killed by fall slash burning. Thus it appears that Douglas-fir slash on clearcuts is not a beetle hazard. This bears out general experience of several decades.

A 10-year study of Douglas-fir mortality in Coos County, Oreg., was completed. Studies in a 180-year-old stand were initiated in 1946 mainly to assess the role of the Douglas-fir beetle. During the study period, 60 percent of the mortality in the stand was credited to the beetle. Other important causes of tree killing were wind, suppression, and disease. Average annual mortality per acre on the study plots, gross measurements, ranged from 60 board-feet in 1955 to 5,000 board-feet in 1951.

THE CHERMES PROBLEM

This insect, also known as the balsam woolly aphid, currently is the worst tree killer in Oregon and Washington. More than 355,000 acres of Pacific silver fir, subalpine fir, and grand fir are infested. Heavy killing of sawtimber-sized trees is occurring, especially in the vicinity of Mount St. Helens, Wash. Salvage is generally well underway but much more is planned. No effective control measures have been developed.

In October the Northwest Forest Pest Action Council formed a committee to investigate the Chermes problem and to stimulate action. The committee has outlined needs, including several lines of research, and the station's program is being developed around these needs.

Research to date on Chermes has been a cooperative undertaking by the station and Weyerhaeuser Timber Company. Exploratory studies are in progress to determine trends of infestation, biology and habits of the insect, and causes of natural control. A summary of what is known about Chermes in the Northwest has been made and will soon be published.

Surveys show the infestation to be spreading and tree mortality to be increasing. The insect deforms and kills trees by attacking the twigs, branches, and main bole. Infestation in the crown may kill the terminal and lateral buds, causing the tree to die slowly.

Chermes infestation on main stem of a young fir.

Infestations on the bole causes the tree to die much more rapidly. Two species of predaceous flies have been found feeding on the aphid, but so far they do not appear important in controlling it.

SILVER FIR BEETLE STUDIES

The infestation of silver fir beetles (Pseudohylesinus spp.) that was discovered in northern Washington in 1947 reached a peak of 600,000 acres in 1954, dropped sharply to 100,000 acres in 1955, and became almost non-existent in 1956. Decline of the outbreak made it possible to put less effort into survey and salvage activities and more into research on biology, ecology, and control. Through the use of trap trees and intensive rearing studies in northern Washington, considerable information about the insects was obtained.

The life cycle of one of the two bark beetles under study, Pseudohylesinus grandis, has been worked out, and the nature of overlapping generations determined. The life cycle in the vicinity of Mount Baker, Wash., is 24 months. Adults emerge in August and make feeding attacks, but lay no eggs. These adults overwinter in hibernating holes in the bark and re-emerge the following spring in late May or early June. Eggs are laid shortly after emergence and hatch in about two weeks. Larvae develop throughout the summer and overwinter as immature larvae. Larvae continue to develop the following spring, maturing and pupating in July. New adults emerge in August, completing the 24-month life cycle for one generation. The overlapping of generations commonly found, is explained by the simultaneous presence of different stages from alternate generations.

Through the use of a recording hygrothermograph and trap trees, information is being obtained to correlate climatic data with the period of flight and attack by the beetles and their subsequent development. This study is to be continued for several years.

Observations made in the spring of 1956 indicated that the "deep freeze" of November 1955 caused less than 20 percent mortality among overwintering larvae. Samples of insect-attacking fungi and bacteria, as well as hymenopterous parasites affecting the larvae, have been collected and are being identified. A relationship appears to exist between a root rot fungus, Armillaria mellea, and the beetles. Studies are being conducted to determine the nature of this relationship.

Cooperative plots established in 1954 to record trends of mortality caused by silver fir beetles were reinventoried and the data evaluated. Records for the Mount Baker area show a decrease in mortality from 13 percent of the plot trees in 1954 to 1 percent in 1956, and an increase in the ratio of good-to poor-risk trees. Records taken on the Olympic peninsula show very little change in a generally good situation.

The Silver Fir Beetle Committee of the Northwest Forest Pest Action Council continued to provide leadership and guidance for research and survey on the silver fir beetle problem. Committee meetings were held in the spring and fall, and an annual report was presented to the Council.

PLANS FOR FOREST INSECT RESEARCH IN 1957

All projects currently active will be continued. More effort will be expended on Chermes; less, on the silver fir beetles. A start will be made on a study of the diseases of bark beetles. Improvement of insect survey techniques will be carried on as part of the consolidated station-wide program for the improvement of aerial survey techniques. By projects, plans for 1957 are:

1. Surveys: Conduct and coordinate the cooperative, regional, forest-insect survey and such special surveys as are needed. Report findings to timber owners and forest-managing agencies.

2. Technical Supervision of Control: This service will be given where needed. Since no large-scale control is planned, needs should be few.

3. Improvement of Survey Methods: Continue efforts to develop and apply aerial-photographic methods for detecting and evaluating insect outbreaks, especially those of the Douglas-fir beetle, western pine beetle, and Chermes.

4. Spruce Budworm: Continue current studies of budworm populations and assessment of natural control.

5. Chermes: (a.) Continue to evaluate trend of mortality on permanent ground plots. (b.) Investigate the possibility of using aerial photographs for assessing mortality and following trend. (c.) Study the biology and habits of the insect. (d.) Assess the

effectiveness of native predators and investigate the possibility of importing European ones.

6. Douglas-fir Beetle: (a.) Continue studies of relationships between stand conditions and beetle outbreaks. (b.) Continue long-term studies for evaluating mortality in Douglas-fir stands. (c.) Initiate studies to determine what the effect time of cutting has upon subsequent Douglas-fir beetle attack and development.

7. Silver Fir Beetles: Continue studies along the same general lines and publish accumulated findings.

8. Sitka Spruce Weevil: In cooperation with Crown Zellerbach Corporation, examine study plots in Clatsop and Tillamook Counties. Publish findings to date on the biology and habits of the insect.

FOREST MANAGEMENT RESEARCH

During 1956 the most noteworthy change in program was the initiation of forest-management studies for the first time at the Blue Mountain Research Center in eastern Oregon. Through cooperation with the Pilot Rock Lumber Company, a preliminary survey of stand and soil characteristics of lodgepole pine forests in the Blue Mountains was started in June. Field work was completed in late November, and the findings are helping to pinpoint key research problems in this long-neglected forest type.

One major task in which all members of the division participated was the preparation of a national manual, Silvical Characteristics of Important Forest Trees of the United States. The division's contribution was to compile available information for 13 tree species native to the Pacific Northwest. At year's end, manuscripts by individual staff members had been reviewed, revised, and were ready for final editing and submission to the Washington Office. Since the national manual may not be published for a year or more, some of the papers covering Northwest species may be published individually by the Station for local distribution.

GENETICS

Douglas-fir Pollen Dispersion

Initial records on dispersion of Douglas-fir pollen indicate that it may be very difficult to isolate Douglas-fir seed orchards from outside pollen contamination. During the 1956 pollen flight, vaseline-coated slides were distributed at varying distances from four isolated Douglas-firs in the Willamette Valley. Pollen counts on the slides showed that during light winds, most pollen fell within a few hundred feet of parent trees. During strong winds, however, large quantities were carried as far as 2,000 feet, the maximum distance studied. Additional slides placed in the center of a large treeless area showed a pollen count of over 800 grains per square inch. In this case, the nearest Douglas-fir tree was more than a mile away.

Field Grafting Ponderosa Pine

A plus-tree archives has been started at the Bend Nursery to preserve trees from the ponderosa pine region that display unusual or exceptional characteristics. Because early grafts had failed, a study was made to determine which method was best adapted for grafting ponderosa pine under the very dry atmospheric conditions of the Bend area. The cleft graft which provides minimum exposure of the cut surface to the air proved to be distinctly superior. Other methods tested were bottle graft, whip graft, bark-patch graft and budding.

Ponderosa Pine Regional Races

Analysis was begun during 1956 of a 25-year growth record for five plantations where seed origin ranged from Washington and Montana on the north to California, Arizona, and New Mexico on the south. In three plantations west of the Cascade Range, tree heights were found to be related to change in elevation from origin to planting site. For two plantations east of the Cascades, in contrast, tree heights were more closely related to change in latitude, with the more northerly or southerly races generally shorter. Cooperators in this longtime study are the School of Forestry, Oregon State College, and the College of Forestry, University of Washington.

Free-Growing Ponderosa Pine

Study of open-grown trees provides one means of estimating possible improvement through selection and breeding. On a site III area south of Bend, Oreg., 30-year-old trees (spaced at least 80 feet apart) ranged in mean annual height growth from 0.9 to 1.6 feet, and in diameter growth from 0.33 to 0.62 inches. Much of the variation in diameter was related to density of ground vegetation (shrubs, grass, and weeds), but tree height was unaffected. Average number of limbs per whorl varied from 2.8 to 5.3, and differences between trees were consistent year after year. Other characteristics such as cone production, crown shape, and tree form also varied greatly but could be largely accounted for by differences in growth rate.

Introduced Trees at Cascade Head

Between 1937 and 1947, some 12 tree species were planted in a bracken fern area in western Oregon in small-scale adaptability trials. So far only two--Port-Orford-cedar and red pine--have demonstrated good enough survival and growth to indicate promise for further trials in similar areas. Redwood, with fairly good survival and growth rate, has developed poor form from repeated frost injury. Species that failed were: baldcypress, black cottonwood, black walnut, cascara buckthorn, giant sequoia, hybrid poplars, Monterey pine, Norway spruce, and white fir. Damage by mountain beaver, rabbits, or deer caused a majority of failures. Height growth of the red pine and Port-Orford-cedar was less than that of Douglas-fir and red alder in surrounding natural stands, but about equal to Sitka spruce and western hemlock's.

SILVICS

Effects of November 1955 Cold Wave

Wintertime observations early in 1956 showed that of native trees in western Washington, western hemlock was damaged most heavily, followed in order by western redcedar and Douglas-fir. Sitka spruce and true firs largely escaped injury. Among hardwoods, red alder, black cottonwood, and Pacific madrone were seriously damaged. Two introduced species--Port-Orford-cedar and redwood--were often killed outright. More recent studies of litter fall, diameter growth, and leader growth showed the precedent-breaking freeze left its imprint on young forests, although native trees generally demonstrated a remarkable ability to recover quickly. Preliminary examination further indicates that the anticipated epidemic of bark beetles in damaged Douglas-fir is not likely to materialize. Damage to tree seedlings was less severe than indicated by early estimates. Losses in 1-0 nursery stock (except true firs) were heavy, but 2-0 stock was little damaged. The Puget Sound Research Center Advisory Committee took the lead in collecting and compiling this damage information.

Seasonal Stem Growth at McCleary Forest

Seasonal stem growth of red alder, western redcedar, and Douglas-fir has been studied on the McCleary Experimental Forest in western Washington since 1954. The McCleary Experimental

Forest is a cooperative undertaking with the Simpson Logging Co. of Shelton, Wash. Three years' record of radial increment on 40 selected trees, measured by dial-gage dendrometer, indicated that stem growth begins during the first week of May and ends in late September or early October. Growth of all three species began about the same time each year but seemed to end earlier for red alder and western redcedar. Radial growth, as shown in the following tabulation, was appreciably less during the 1956 growing season --presumably an effect of the cold wave in November 1955.

Species	1954 (inches)	1955 (inches)	1956 (inches)
Red alder	0.05	0.06	0.03
Western redcedar	.06	.08	.05
Douglas-fir	.08	.10	.07

Litter Fall at Voight Creek

Thinning in 45-year-old Douglas-fir was found to have a pronounced and immediate effect on amount of litter, produced annually. Based on a 6-year record, average annual litter fall for four thinning treatments was as follows:

Treatment	Annual litter fall (pounds per acre)
Heavy thinning	1,024
Medium thinning	1,285
Light thinning	1,390
No thinning	1,575

Litter fall usually reached a maximum in October and a minimum in late winter and early spring. In the 10-month period following the severe November cold wave in 1955, litter fall was nearly three times as heavy as in previous years. Research on the Voight Creek Experimental Forest is made possible through the cooperation of the St. Paul and Tacoma Lumber Co.

Alder as a Nurse Crop

In 1933, a strip through a 4-year-old plantation of Douglas-fir at Wind River was interplanted with red alder. Located in part of the old Yacolt Burn, the original intent was to test the value of planted alder as a firebreak. Now 27 years old, the plantation affords a unique opportunity to study the influence of alder as a soil-improving species and to measure relative growth of planted Douglas-fir within and outside the alder strip. Preliminary findings from a 1956 study indicated that:

1. Soil under the alder-fir mixture contains more nitrogen, calcium, and magnesium than under the pure Douglas-fir planting.

2. Total basal area of both species within the alder interplanting is almost twice as much as for Douglas-fir alone.

3. Despite heavier stand competition, Douglas-firs within the alder-fir strip are about equal in average diameter and total height to Douglas-firs outside the strip.

4. Current diameter and height growth of dominant Douglas-firs within the alder-fir mixture exceeds that of dominants outside the strip.

Because of its sea-level source, the alder has been subjected to recurrent winter damage at the 2,400-foot elevation of the test planting. This phenomena has enabled the Douglas-firs to compete with a fair degree of success. The alder-fir strip now contains 440 Douglas-fir stems per acre compared with 560 in the pure-fir planting.

SEEDING AND PLANTING

Depth of Sowing

How deep should seed of sugar pine and ponderosa pine be planted in seed-spotting operations in southwestern Oregon? To help answer this question a carefully controlled field study was undertaken on three soils--pumice, silty clay loam, and clay loam. Seeds were sown on the surface and at depths of 1/4, 1/2, 1, and 1-1/2

inches. Depth of best germination and best survival at the end of the first season was as follows:

Species	Soil	Depth of best--	
		Germination (inches)	Survival (inches)
Sugar pine	Pumice	1	1
	Silty clay loam	1	1/2
	Clay loam	1/4	1/2
Ponderosa pine	Pumice	1/2	1/2
	Silty clay loam	0 (Surface	1/2
	Clay loam	0 (sown	1/4

Optimum depth varied both with species and type of soil. Based on first year survival, results showed that sugar pine seed should be sown at a depth of 1 inch in pumice and 1/2 inch in silty clay loam and clay loam. For ponderosa pine seed, sowing depths of 1/2 inch in both pumice and silty clay loam and 1/4 inch in clay loam are indicated. Among other things, the study revealed that broadcast seeding may hold promise for ponderosa pine on soils of medium to heavy texture.

Delayed Germination

Second-year checks of areas broadcast seeded on the Olympic National Forest showed that delayed germination of Douglas-fir seed can be a major factor in determining ultimate success or failure of a direct-seeding operation. The fact that unseeded plots remained nonstocked in both years gave proof that natural seeding from windborne seed had not fouled up the study. As shown in the following tabulation, delayed germination was most pronounced with tetramine-treated seed and least pronounced with untreated seed:

Seed treatment	New seedlings per acre, both years (Number)	Proportion germinating the second year (Percent)
Tetramine	1,398	64
Endrin	9,866	31
Untreated	875	26

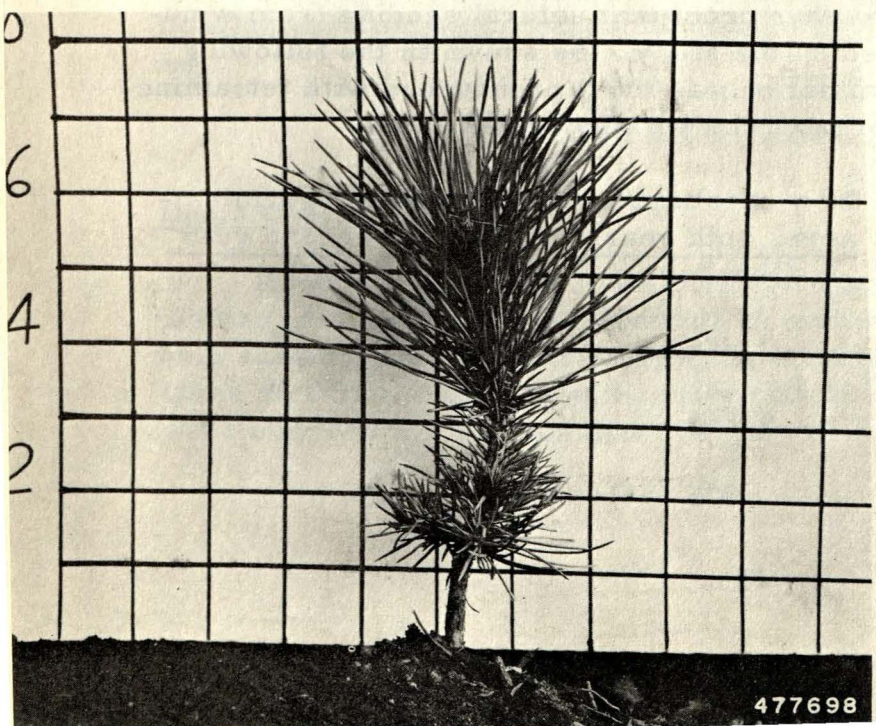
Late sowing (end of March and early April, 1955) is believed accountable for the large holdover germination in 1956. Stocking at the end of the second growing season (milacre basis) indicated endrin was just as effective as tetramine in protecting Douglas-fir seed and seedlings from rodent losses:

Treatment	Stocking (Percent)
Tetramine	47
Endrin	55
Untreated	27
Unseeded	0

Through its Denver Wildlife Research Laboratory and Branch of Predator and Rodent Control, the U.S. Fish and Wildlife Service has provided substantial help in studies of rodent control in direct seeding.

Seed-Spotting in Southwestern Oregon

Seed spotting of ponderosa pine and sugar pine is rapidly moving out of the pilot plant stage as trials show consistent success year after year. Five clear-cut areas in the South Umpqua drainage, totaling 124 acres, were seeded to sugar pine on an operational



A vigorous 2-year-old sugar pine seedling established through seed spotting.

Gophers clipped the stems of planted Douglas-firs both above and below ground level.

basis late in 1955. In 1956, a mid-June examination of one area showed seedlings had germinated in 61 percent of the planted spots and that 47 percent of the spots contained one or more live seedlings. Preliminary recommendations for seed spotting sugar pine were summarized in Station Research Note 118. Current practices follow these guidelines closely.

Good success has also followed pilot-scale seedings of ponderosa pine on pumice soils in the vicinity of Diamond Lake. A 20-acre tract, seed spotted in the fall of 1954, is now 71 percent stocked (milacre basis) with established seedlings. A 37-acre area in the same locality was seed spotted with ponderosa pine in the fall of 1955 (4- by 8-foot spacing). Recent checks showed that 42 percent of these seed spots contained one or more live seedlings.

Survival of Planted Douglas-fir

In an attempt to increase survival of planted Douglas-fir seedlings in southwestern Oregon, several treatments were tested on 2-0 seedlings planted in the fall. Survival of seedlings planted extra deep was only 38 percent--about equal to survival of seedlings planted at the usual depth. Survival of seedlings either dipped in a transpiration inhibitor or top pruned was substantially less. Gopher activity was an important cause of mortality.

A closely related study provides a measure of the influence of shade on survival of planted Douglas-fir in southwestern Oregon.

First year survival was 59 percent for seedlings planted in "dead" shade (logging debris), compared with 50 percent in "live" shade (vegetation) and only 35 percent in unshaded locations.

Mycorrhizae and Seedling Growth

Five specific fungi-tree relationships were examined, identified, and reported during 1956. This needed background information is proving helpful in the planning of a new study in cooperation with the College of Forestry, University of Washington, to determine the influence of certain mycorrhizal fungi on development and survival of ponderosa pine and western larch seedlings. This investigation should help to explain more fully the role of mycorrhizae in the success or failure of plantations.

BRUSH CONTROL

Central Oregon

Continuing tests of chemical control for problem brush species of the Deschutes country indicate that 2, 4, 5-T is more effective than 2, 4-D on snowbrush (Ceanothus velutinus) and chinkapin (Castanopsis sempervirens); equally effective as 2, 4-D on manzanita (Arctostaphylos parryana var. pinetorum); and less damaging than 2, 4-D to ponderosa pine. For controlling brush in central Oregon areas where ponderosa pine is intermingled, the following tentative recommendations are therefore suggested for small-scale trials:

1. For manzanita and chinkapin, spray with 1/2 pound (acid equivalent) of 2, 4, 5-T per acre in 5 gallons of oil emulsion (containing one gallon of oil).

2. For snowbrush, spray with 1 pound (acid equivalent) of 2, 4, 5-T per acre in 5 gallons of oil emulsion (containing 1 gallon of oil).

These concentrations are not believed heavy enough to cause excessive damage to ponderosa pine.

Where brush is primarily manzanita and protection of intermingled ponderosa pines is not a problem, 2, 4-D can be used to advantage since it is a cheaper chemical.

Southwestern Oregon

The brush problem in southwestern Oregon is especially challenging. Some 315,000 acres are practically solid brush. An additional 1,800,000 acres are partially stocked with trees, but brush seriously hinders full timber production. That there are a very large number of shrub species further complicates the control problem.

Screening tests of various herbicides on major problem shrubs were started in 1955 and began to yield results during 1956. Chemicals tested included trichlorobenzoic acid in both sodium salt and oil soluble forms, animo-triazole, and low volatile esters of 2, 4-D, 2, 4, 5-T, 2, 4-DP, and 2, 4, 5-TP. Based on second-year results, shrub species were grouped into 3 susceptibility classes as shown below. The letter D (2, 4-D) or T (2, 4, 5-T) following the scientific name indicates the chemical that proved most effective for that species during initial screening tests.

1. Susceptible.--Entire plant killed with low concentrations of herbicides:

   Hairy manzanita (Arctostaphylos columbiana)--D.

   Hoary manzanita (Arctostaphylos canescenes)--D.

   Big manzanita (Arctostaphylos manzanita)[2/]--D.

2/ Identification tentative. The assistance of A. N. Steward, Curator of Herbarium, Oregon State College School of Science, in identifying shrub species in southwest Oregon is gratefully acknowledged.

Young ponderosa pine released from severe competition of manzanita brush through chemical control.

2. Moderately susceptible.--Aerial portions readily killed with herbicides, but resprouting from root crown common:

   Greenleaf manzanita (Arctostaphylos patula)--D.

   Deerbrush (Ceanothus integerrimus)--D.

   Snowbrush (Ceanothus velutinus)--T.

   Snowbrush (Ceanothus velutinus var. laevigatus)--T.

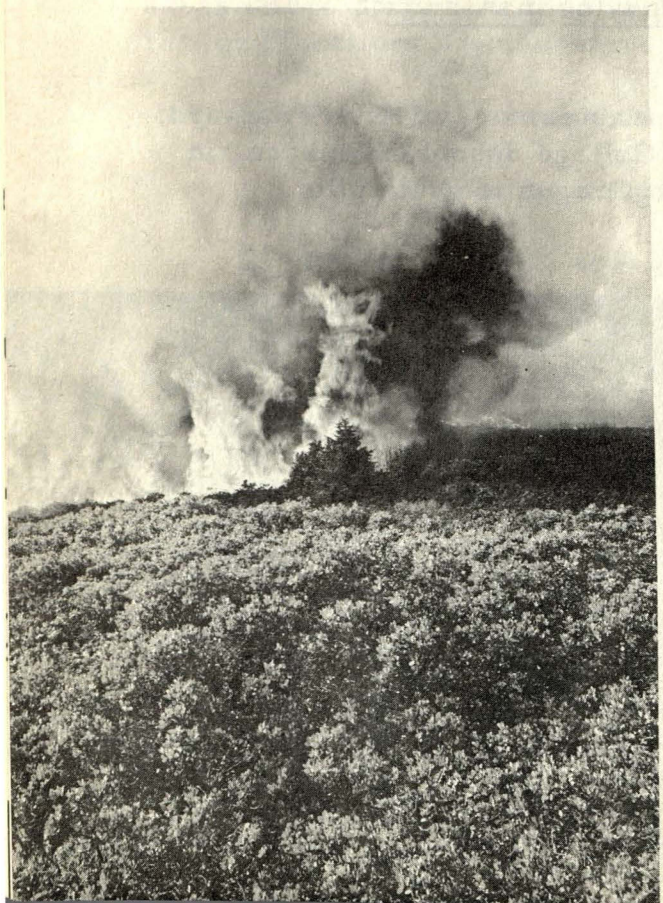
   Mountain whitethorn (Ceanothus cordulatus)--T.

3. Resistant.--Only portions of stem and branches killed by herbicides. None of chemicals tested provided acceptable control:

   Golden chinkapin (Castanopsis chrysophylla var. minor)--T.

   Canyon live oak, shrub form (Quercus chrysolepsis)--D.

   Tanoak (Lithocarpus densiflorus)--T.



Chemically treated brush proved to be a flashy fuel. It burned hot and fast and cooled rapidly.

Serviceberry (Amelanchier florida)--T.

For control of long-stoloned sedge (Carex inops), which also competes seriously with conifer regeneration on certain pumice soils, a sodium salt of 2, 2-dichloropropionic acid looked most primising. Although minimum dosage has not been determined, acceptable control was obtained by thoroughly wetting sedge clumps with a 1-percent solution (by weight) in water.

A closely related study to determine the resistance of conifer reproduction in southwest Oregon to low concentrations of 2, 4-D and 2, 4, 5-T was begun in 1956. Initial results from midsummer foliage sprays show that Douglas-fir is far more resistant than ponderosa pine or sugar pine. Both pines were heavily defoliated in all treatments. Damage was less severe, however, when chemicals were applied in water carrier than in oil emulsion.

A pilot-scale test combining chemical sprays and burning for the reclamation of brush fields has been under way since 1955 on the Onion Mountain area of the Siskiyou National Forest. Three areas totaling 100 acres were sprayed aerially in July 1955, using 2, 4-D and 2, 4, 5-T alone and in combination. Of three major brush species, a good top kill resulted on greenleaf manzanita and some dieback occurred on chinkapin and canyon live oak. By July 1956, however, all species had resprouted vigorously. Some 80 acres of the chemically treated brush were therefore burned in September 1956, using slash-burning techniques.

Prescribed fire helped to prepare this area for reforestation. It cleaned up the almost impenetrable mass of dead brush and killed back new sprouts.

In November, one 5-acre test plot in the burned area was planted with 2-0 ponderosa pine; a second was seeded with endrin-treated ponderosa pine seed. Additional herbicide treatments may be needed to protect new trees from competition of brush plants that resprout.

Northwestern Oregon

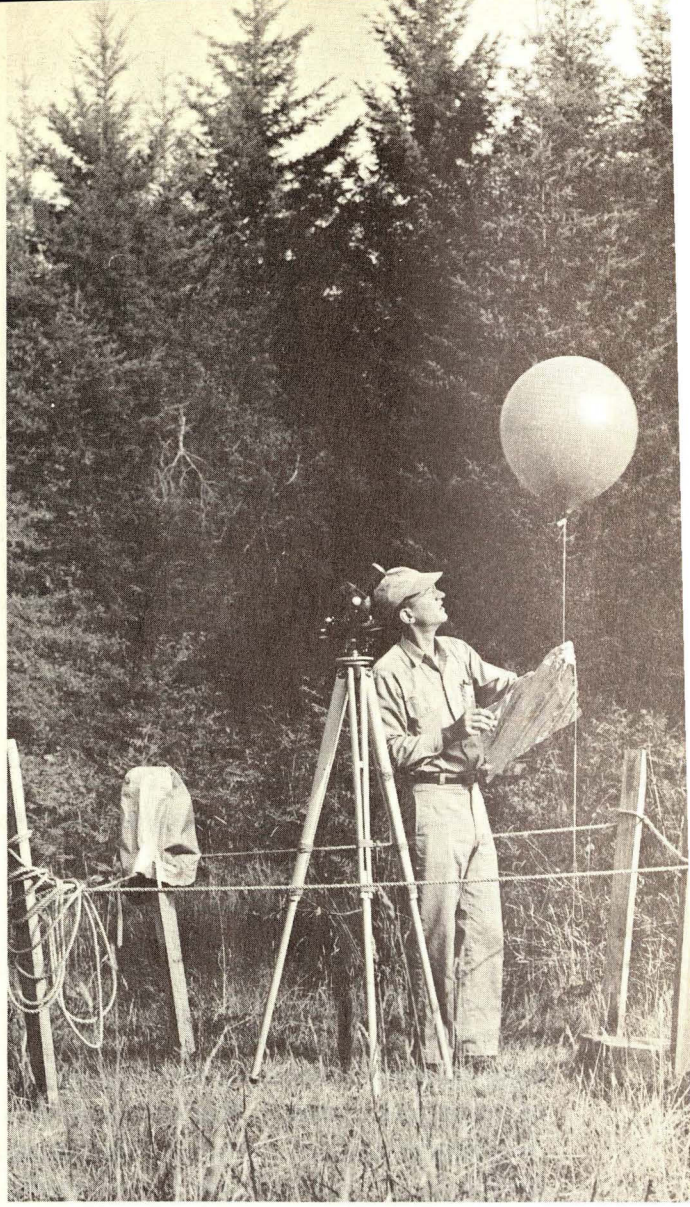
In the coastal zone, previous work has demonstrated that alder can be cheaply controlled with foliage sprays applied by airplane. Basal applications of 2, 4-D have also proved successful for patches of alder too small for aerial application or too tall for foliage spraying from the ground. These trials at the Cascade Head Experimental Forest were in cooperation with the Publishers' Paper Co. Salmonberry has likewise been successfully killed by basal treatment, but the search still goes on for a chemical that will provide satisfactory and cheap control as a foliage spray. During 1956, bigleaf maple--which creates a problem on many low-elevation clearcuts in the Willamette Valley area--received attention for the first time, in cooperation with the Forest Experiment Station, Oregon State College, and the U. S. Bureau of Land Management. Many maples left after cutting are old and defective and their wide-spreading crowns shade out Douglas-fir seedlings. Chemical control of these larger trees through both stem and stump treatments are being investigated.

FIRE RESEARCH

Wind Over the Mountains

A series of studies to provide a better understanding of wind behavior over mountainous terrain was begun during August in cooperation with the U. S. Weather Bureau and the Oregon State Board of Forestry. The first step was an intensive field investigation of wind patterns over a 1,600-square-mile area in the Oregon Coast Range, near Valsetz. Several techniques for observing wind flow were tried, including pilot balloon runs and use of specially installed wind recorders on several exposed peaks.

Improved knowledge of the effects of rough topography on wind flow can be expected to eventually lead to substantial improvements in accuracy of wind forecasts for mountainous parts of the region.



Meanderings of surface winds were traced by observing very slowly rising balloons through 2 theodolites spaced 1,900 feet apart.

Slash-Burning in the Douglas-fir Region

Recent appraisal of a widely scattered series of burned and unburned slash plots established following patch cutting indicates that burning greatly reduced fire hazard and brush density but did not exert a pronounced effect on the re-establishment of natural regeneration. Related studies had already demonstrated that slash burning does not appreciably damage chemical, physical, or biological properties of the soil. Most slash areas are burned in periods when the lower duff is moist. As a result, only a very small percentage of the surface is severely burned.

For study areas in the Cascade Range, restocking through natural seeding was very slow and averaged less than medium

stocked after five years. At this time, brushy vegetation covered 20 percent of the unburned areas but only 10 percent of the areas where slash had been burned. In the Coast Range, restocking was much more rapid, and brush was much denser. These results apply to the first 5 to 7 years following burning.

Prescribed Burning in Ponderosa Pine

Several trials of burning as a silvicultural tool for thinning dense stands of young ponderosa pine have been undertaken in various parts of the West. A 1942 trial by the U. S. Bureau of Indian Affairs in a sapling-size stand on the Colville Indian Reservation reduced the stand from 2,500 to 1,000 stems per acre. Study of crop trees (80 per acre) for the first 6 years after burning showed that diameter growth was 37 percent greater and height growth 9 percent greater on burned than on unburned areas. Many crop trees showed fire scars on their trunks after 6 years. These scarred crop trees grew less in height, but diameter growth was not reduced.

Seasonal Fire-Weather Ratings

As part of an increased-manning study on the Willamette National Forest, fire occurrence was found to be closely related to certain seasonal weather factors measured at Eugene. Number of man-caused fires varied directly with burning index and total number of rainless days. Percentage of fires confined within 1/4 -acre was inversely related to average burning index. Percentage of fires that burned 100 acres or more was directly related to average burning index. These relationships may prove helpful in isolating fire-weather effects when appraising possible gains from intensified protection efforts.

THINNING AND SALVAGE CUTTING

Crop-Tree Release in Very Young Ponderosa Pine

Crop-tree release was formerly considered of questionable value for precommercial thinnings in sapling- and small-pole-size thickets of ponderosa pine. However, new studies on the Snoqualmie and Deschutes National Forests show this type of thinning accelerates crop-tree growth substantially.

On the Snoqualmie, released crop trees grew 0.93 inches in diameter during 5 years following thinning, compared with 0.52

inches for unreleased crop trees. In this test, thinning removed all competing trees within 7 feet of selected crop trees.

In the Deschutes trial, two degrees of release were tested with and without the influence of overstory competition. Diameter growth of crop trees during the 5 years after treatment was as follows:

Degree of release around crop tree	Overstory present (inches)	Overstory removed (inches)
None	0.45	0.73
5 feet	.59	1.03
7-1/2 feet	.70	.97

Removal of overstory competition, which averaged about 10,000 board-feet per acre in old-growth trees, apparently influenced diameter growth of selected crop trees even more than removal of surrounding saplings and small poles.

Growth After Commercial Thinning in 68-Year-Old Douglas-fir

Sample plot remeasurements during 1956 on 140 acres of the Hood Canal Experimental Forest, which is maintained in cooperation with Pope and Talbot, Inc., have been analyzed to compare growth rates in thinned and unthinned stands. Net periodic increment of 203 cubic feet annually per acre on an unthinned check compartment contrasts with 175 and 140 cubic feet on lightly and heavily thinned compartments, respectively (table 1).

It is apparent that increment was confounded by site and growing stock volume. In terms of growth percent, however, increment was about equal on all compartments. It may be inferred that thinning did not stimulate increment. Failure to increase diameter growth may be due to the advanced age of the stand.

Table 1.--Increment for a 68-year-old Douglas-fir stand over a 4-1/2-year period, by thinning treatment

Thinning treatment	Site index (feet)	Volume per acre after thinning		Periodic annual increment per acre		
		Cubic feet	Scribner board-feet	Cubic feet	Scribner board-feet	Scribner growth percent
Light	144	7,453	29,861	175	1,067	3.3
Heavy	141	6,144	23,182	140	776	3.1
None	167	9,772	42,726	203	1,474	3.2

Growth After Commercial Thinning in 105-Year-Old Ponderosa Pine

Trial thinnings of ponderosa pine in 1949 removed 3,000 and 5,000 board-feet, respectively, from a 105-year-old stand that averaged about 29,300 board-feet per acre. The study is on a portion of the Pringle Falls Experimental Forest that averages low III in site quality. During 6 years following thinning, annual net growth in thinned stands averaged 555 board-feet per acre with no appreciable difference between the two degrees of thinning. Growth in the unthinned stands was slightly greater--600 board feet. Reasonable projections of future stand development indicate that 2 or 3 additional thinnings of about 5,000 board-feet can be made at 15-year intervals without lowering the final harvest of full yield-table volume at 180 years of age.

Thinning With Horses

Horses are proving particularly adapted to removal of small logs in light, frequent cuts where skidding distances do not exceed 500-600 feet. Experience on 5 projects totaling 3,000 cords of pulpwood and sawtimber in the Puget Sound area showed an average skidding cost of $5.47 per cord and a daily production of 4.56 cords per skidding unit (a teamster and one horse). Cost of operating and maintaining a horse for woods skidding ranged from 28 to 45 cents and averaged 40 cents per hour based on a working year of 1,600

hours. As shown below, feed alone accounted for over two-thirds of the average annual maintenance cost per horse:

Item	Annual cost	Percentage of total
Feed	$ 435.84	69
Harness and equipment	64.05	10
Shoeing and veterinary service	58.22	9
Shelter	19.40	3
Depreciation of horse	26.40	4
Taxes, insurance, and interest	13.75	2
Miscellaneous	16.25	3
Total	$ 633.91	100

High-Lead Salvage in Leave Settings

Staggered-setting cutting in old-growth Douglas-fir affords a real opportunity for periodic salvage of mortality in leave settings. Past efforts, however, have been confined mainly to gentle slopes where tractors can operate efficiently. Cable yarding with a mobile logging machine seemed promising for salvage of steeper slopes and a trial was begun on the H. J. Andrews Experimental Forest in 1954. Permanent roads had already been built through the leave settings to reach clearcuts beyond, so only short stretches of low-standard road had to be constructed for the salvage operation. Immediate interest in the test centered around two questions: Would logging damage to the live stand be excessive? Would logging costs be prohibitive? With some qualification, the answer to both questions was "no."

Reserve hemlock and redcedar trees bore the brunt of logging damage, with almost one-third showing some injury. However, only 5 percent of the reserve Douglas-firs were damaged and

Mobile logger rigged for cable yarding on a low-cost spur road. Maximum yarding distance was 500 to 600 feet.

individual injuries were not severe. The test indicated that logging damage can be kept to an acceptable level if the operation is carefully planned in advance and if the loggers exercise a high degree of skill in setting chokers and in yarding logs past obstructing trees.

Yarding costs were higher than in clear-cutting operations using high-lead yarding, but the difference was partly offset by lower costs for road construction. Total recovery from salvage on the 111-acre test area was slightly over a million board-feet of high-quality material. The study of yarding costs was made through cooperation with the Skagit Iron and Steel Works.

GROWTH, YIELD, AND STAND CHARACTERISTICS

Culmination of Growth in Douglas-fir

A 42-year record of growth in a fully stocked site III stand at Wind River shows that mean annual increment culminated at age 81 in cubic feet and at age 86 in board-feet (Scribner rule). At culmination age, mean annual increment was 140 cubic feet and 681 board-feet per acre. The stand is now 114 years old and mean annual net increment has fallen off from these maximums by 22 percent in cubic volume and 14 percent in board-feet. In contrast, mean annual gross increment (including mortality since age 72) has been nearly constant at 145 to 150 cubic feet since age 83. By Scribner measure, the mean annual gross increment of 762 board-feet attained at 114 years was higher than at any earlier age. These figures demonstrate in a striking way how increased yields (with longer

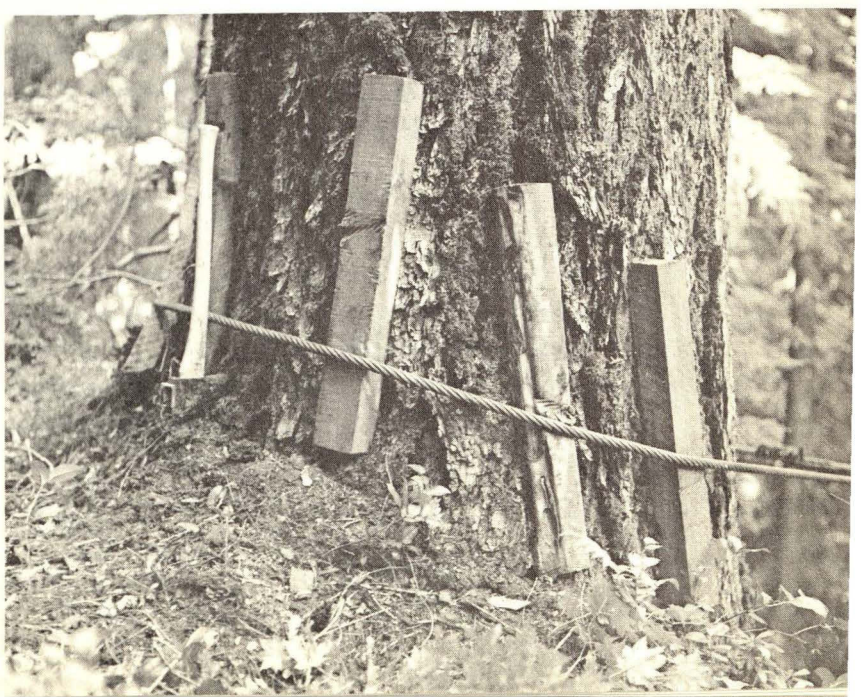
rotations) can be realized under a plan of management where full forest production is harvested through periodic thinnings.

Realized Increment Under a Thinning Regime in Western Hemlock

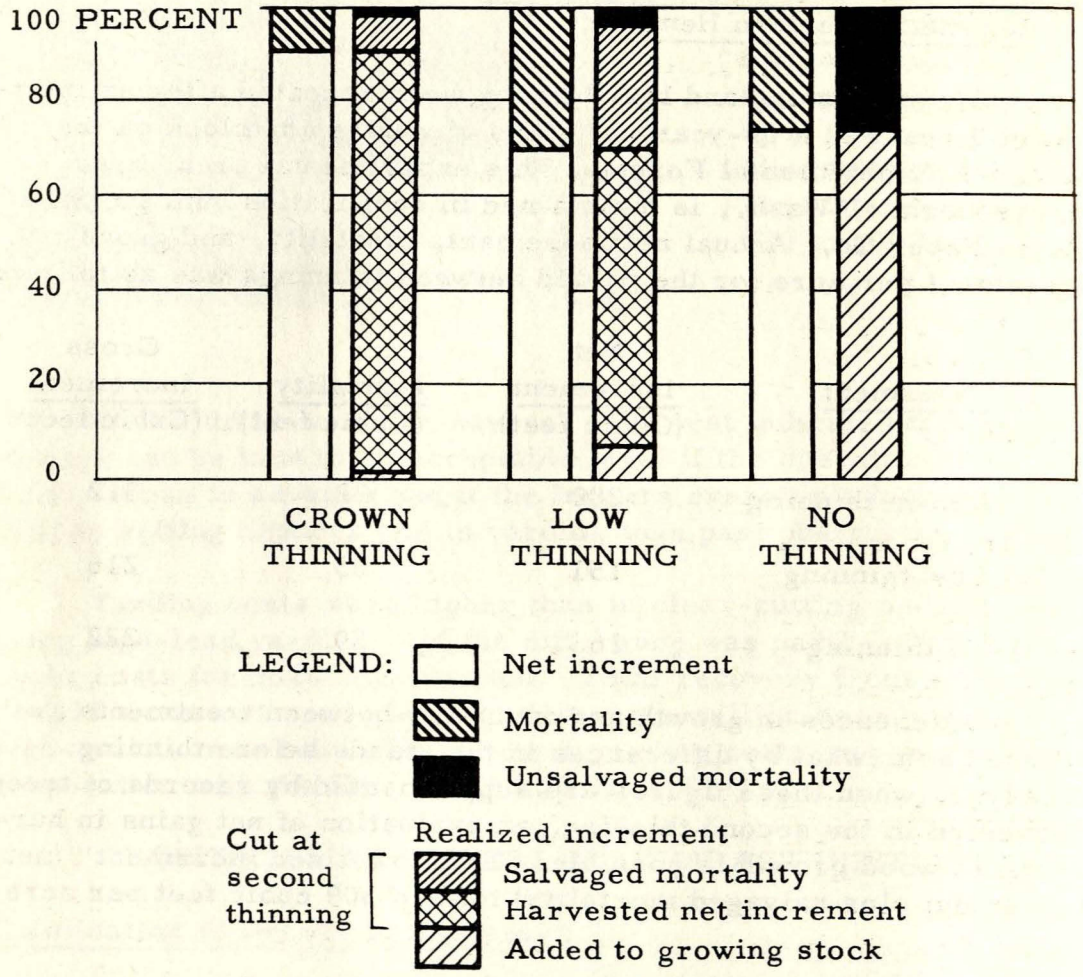
Crown thinning and low thinning were repeated after an interval of 3 years in a 50-year-old stand of western hemlock on the Hemlock Experimental Forest. This experimental area, near Grays Harbor, Wash., is maintained in cooperation with the St. Regis Paper Co. Annual net increment, mortality, and gross increment per acre for the period between thinnings was as follows:

Treatment	Net increment (Cubic feet)	Mortality (Cubic feet)	Gross increment (Cubic feet)
Crown thinning	280	32	312
Low thinning	151	65	216
No thinning	163	59	222

Differences in growth and mortality between treatments are masked somewhat by differences in the stands before thinning. However, when these figures are supplemented by records of trees harvested in the second thinning, an evaluation of net gains in harvestable wood growth is possible. This "realized increment" (net increment plus salvaged mortality) totaled 309 cubic feet per acre



Yew-wood blocks under guy lines help protect green trees from damage.



Crown thinning in a 50-year-old stand of western hemlock produced the greatest returns in "realized increment" (net increment plus salvaged mortality). Disposition of gross increment into its four component parts, above, shows advantage of light, frequent thinnings.

annually in the crown thinning, 205 cubic feet in the low thinning, and only 162 cubic feet in the unthinned stand.

State Forest Growth Capacity

A very high productive capacity in young hemlock and hemlock-spruce stands in the Olympic Peninsula area was disclosed through the remeasurement of 12 plots on Washington's Sustained Yield Forest No. 1. Stands now 35 years old, which originated after the 1921 blowdown, support about 80 cords per acre and are currently growing at an annual rate of 293 cubic feet per acre. Older stands (55 to 65 years) support about 69,000 board-feet, Scribner rule, in trees 12 inches and larger, with a current yearly growth rate of 2,200 board-feet per acre.

A Yield Table for Red Alder

Under sponsorship of the Puget Sound Research Center Advisory Committee, substantial progress was made in collection of field data for yield tables covering normal even-aged stands. At year's end, 310 sample plots had been measured in 10 western Washington counties following standard instructions prepared by the Advisory Committee. Altogether some 40 private and public organizations have volunteered assistance in the project.

Stand Characteristics of Lodgepole Pine in the Blue Mountains

A systematic sampling of 50 stands in the Blue Mountains of eastern Oregon provides the first concrete information on age and structure of these stands and on characteristics of their soils.

Most stands sampled were from 55 to 70 years old--a remarkably narrow range. They were essentially even-aged and had become established following a violent disturbance, usually fire. A few stands contained 2 or even 3 distinct age classes as a result of light burns, windthrow, or snowbreak during stand development.

Stand density apparently exerts a pronounced effect on diameters and heights attained by lodgepole pine in this area. Some heavily stocked stands with as many as 15,000 stems per acre were found to average only 1 to 3 inches in diameter and 20 to 30 feet tall after 60 years. In contrast, some stands with less than 500 stems

per acre averaged 6 to 8 inches in diameter and 60 to 70 feet tall at the same age and on a similar site. Evidently site index will need to be modified by a measure of stocking before it can be used with assurance as an expression of productive capacity.

Soils of the Blue Mountains are mostly silts and clays derived from basalt bedrock. Much of this residual soil, especially on flats and north slopes, is overlain with a floury pumice of varying depths. Lodgepole pine occurs only on the pumice soils and is characteristically a north-slope type. However, these same pumice soils also support mixed stands of Douglas-fir, western larch, and white fir. And there is strong evidence that lodgepole pine is present merely as a temporary type following fire.

In even-aged stands, lodgepole pine seems to culminate in both diameter and height at about 40 years of age. Associated species culminate much later. As a result, Douglas-firs, western larches, or white firs that occur in the lodgepole pine areas are commonly half again as large in both diameter and height as lodgepole pine of the same age.

Relative Site Indexes of Sugar Pine and Douglas-fir in the South Umpqua Basin

A study to help provide guidelines for determining which areas should be managed for sugar pine in place of Douglas-fir was continued during the field season. The 1956 data confirmed earlier indications that an elevation of 3,500 to 4,000 feet can be used as a

Fire, many years ago, thinned out part of this lodgepole pine stand (at right) and greatly stimulated growth in both diameter and height.

The lodgepole pine (left) and western larch (right) are both 85 years old. The larch is 16 inches in diameter, compared with only 12 inches for the pine. Growth of lodgepole pine culminates at an earlier age than that of associated species.

first approximation of the upper boundary of sugar pine management units in the South Umpqua area of southwestern Oregon. The close correlation found between site index for Douglas-fir and sugar pine then provides the key to on-the-ground determination of more precise boundaries. Where site index for Douglas-fir is 142 or less, sugar pine can be expected to exceed Douglas-fir in height growth and yields. Where Douglas-fir site index exceeds 142, in contrast, Douglas-fir can be expected to be the more productive species. There are also indications that an accurate soils map of the South Umpqua drainage would be of very practical assistance in determining which species should be favored through management.

PLANS FOR FOREST MANAGEMENT RESEARCH IN 1957

During 1957, greater emphasis will be given research in artificial regeneration, including nursery production, storage, and handling of tree seedlings; planting methods; site preparation; and direct seeding. This move will help to carry out recommendations of both local and national-forest research advisory committees. It will also help to meet increased research needs posed by the forest planting features of the soil bank program. A section of Artificial Regeneration and Soils is being activated in the division office to help provide leadership for these efforts. A new project will be undertaken at the Puget Sound Center to explore means for increasing productivity of nonstocked and poorly stocked areas through both regeneration and cultural measures.

A modest increase in allotments for the current fiscal year makes it possible to initiate a new project on lodgepole pine management at the Deschutes Research center. The technical staff in forest management at the center was increased from 3 to 4 men in January 1957, and a preliminary analysis of problems needing research will be completed prior to the 1957 field season.

Two new studies planned for next year reflect a sharpened interest in optimum levels of growing stock. One is a spacing-increment study for both sugar pine and ponderosa pine on the South Umpqua Experimental Forest. The second is a spacing study for ponderosa pine at the Deschutes Center.

Currently, a major effort at the Puget Sound Center is the preparation of a departmental publication, "Commercial Thinning of Young-Growth Douglas-fir in the Pacific Northwest." This bulletin will cover the theory, practice, and financial aspects of commercial thinning based on some 10 years of trial.

A report being readied for release by the Willamette Center promises to create more than usual interest. Titled "Salvage Logging with a Mobile High-Lead Yarder in Old-Growth Douglas-fir," it will describe a recent trial of salvage logging on the H. J. Andrews Experimental Forest and indicate how periodic salvage, even on steep slopes, can be carried out in leave settings of old-growth Douglas-fir.

At Cascade Head, an exploratory trial of shelterwood cutting in 100-year-old spruce-hemlock will be continued. Interest centers on determining whether or not control of light reaching the forest floor can be used to encourage establishment of natural regeneration and at the same time hold brush development in check. As blowdown may pose a challenging problem, the first shelterwood cutting areas have been carefully selected to afford maximum resistance to wind damage.

In fire-weather studies, interest will center on further analysis of the wind data collected during last year's study in the Oregon Coast Range, and on publication of a report on effects of slash burning in the Douglas-fir region.

At the Blue Mountain Center, forest management personnel will give first priority to reporting the findings from last year's exploratory survey of lodgepole pine.

As a part of the Division's genetics project, a start was made in late 1956 on the 10-year remeasurement of the Wind River Arboretum. Field measurements will be completed during late spring and early summer of 1957 so that 45-year findings may be summarized and released before the end of the year.

Plans have also been completed for the employment of a year-round resident at Wind River, which will provide for improved maintenance of established studies as well as the physical plant.

FOREST PRODUCTS UTILIZATION RESEARCH

During the year there was much consolidating and integrating of wood-using industries in the region. The chief reasons for this trend are to assure raw material supplies through increased timber holdings and to improve utilization of the raw material.

Continually increasing stumpage prices have made it necessary that raw material be better utilized. No longer is it good business to cut the entire timber supply into one product, such as lumber, and to dispose of mill residue in burners. The present practice is to segregate logs for their highest use and to put the residue to some economical use. Many of the medium-size sawmills have installed whole-log barkers, chippers, and veneer lathes. At these plants the better logs are cut into veneer and the others into lumber. Slabs, edgings, waste veneer, and cores are chipped and the material sold to pulp manufacturers. Larger wood-using companies have integrated their operation so that residue from one manufacturing unit can be used as raw material for another. Fiberboard and particleboard plants and some pulp mills are now operating entirely on mill residue from sawmills and plywood plants. This type of integrated operation is expected to continue.

PULP AND PAPER

The Pacific Northwest is in the midst of a large pulp expansion. Several new pulp mills are being constructed or are in the planning stage. In addition, most of the established plants are expanding facilities to increase capacity. This expansion is needed to improve utilization of wood not suitable for lumber or plywood. Remarkable progress has been made by the pulp industry in substituting chips from sawmill and plywood plants for logs as raw material. However, this region still has large quantities of logging and manufacturing residue that could be utilized if there were sufficient pulp capacity.

In young-growth stands, the small material is not suitable for lumber or plywood but could be used by pulp mills. With increased interest in managing timber lands in this region, markets are

needed for materials from thinnings. It will not be possible to get the best forest management until this small material can be utilized.

APPRAISAL-BASE STUDY

Much emphasis was given during the year to an appraisal-base study. This work was begun in 1955 to develop data to be used in appraising federal timber. Stumpage prices for national-forest timber in the Douglas-fir subregion are now established by using the selling price of logs as the starting point. Since there no longer is a free-and-open log market, it is necessary that the starting base be changed to the selling price of lumber, plywood, and other primary products. Before this end-product appraisal system can be established, much data must be developed on the yield of lumber, plywood, and other products from various species, grades, and sizes of logs. Also, production costs and selling prices for the various products are needed.

Lumber-recovery studies were made for western hemlock, white fir, and western redcedar. Detailed recovery information was recorded for the various grades and sizes of logs cut by the lumber industry. Green-chain lumber recovery for No. 2 and No. 3 Sawmill logs for both hemlock and white fir are summarized in table 2.

Six veneer-recovery studies were made to determine the quantity and quality of veneer that can be expected from the small special peelers and the three peeler grades of logs. Recovery data from the six studies has been combined with similar information from studies by a local engineering firm (table 3).

SKYLINE CRANE

During the past two years the Forest Service has participated in a unique skyline logging experiment at Twisp, Wash. The machine used was developed by Jacob Wyssen of Reinbach, Switzerland, for logging timber in mountainous countries. Three models of Wyssen cranes are now in use in many different parts of the world. The one at Twisp is the largest manufactured to date. In this model the skyline is one inch in diameter, the operating cable is one-half inch in diameter, and the single-drum machine is powered by a 4-cylinder, 60-horsepower diesel motor made in Switzerland.

Table 2.--Green-chain lumber recovery for No. 2 and No. 3 Sawmill logs, western hemlock and white fir

Item	Western hemlock				White fir			
	No. 2		No. 3		No. 2		No. 3	
	Bd. ft.	Percent	Bd. ft.	Percent	Bd. ft.	Percent	Bd. ft.	Percent
Net log volume	76,850	-	20,180	-	49,880	-	14,620	-
Lumber tally	103,471	-	29,282	-	67,222	-	20,568	-
Overrun	-	35.0	-	45.0	-	35.0	-	41.0
Recovery in percent of net log scale:								
B & Better	-	7.3	-	2.1	-	3.6	-	0.3
C	-	12.0	-	3.7	-	5.5	-	3.6
D	-	0.4	-	0.2	-	0.4	-	0.2
Select Merchantable	-	0.8	-	1.1	-	0.9	-	1.5
Select Structural	-	23.2	-	22.6	-	25.4	-	16.0
Construction	-	45.5	-	51.4	-	52.8	-	58.8
Standard	-	13.6	-	23.1	-	12.8	-	22.0
Utility	-	23.7	-	33.7	-	25.9	-	30.1
Economy	-	8.1	-	7.2	-	7.5	-	8.2

Table 3.--Veneer recovery from Douglas-fir logs

Peeler log grade	Veneer grade recovery[1/]				Panel recovery ratio[2/]
	A	B	C	D	
	----- Percent of net log scale -----				
No. 1	33	7	26	20	2.3
No. 2	26	7	28	26	2.3
No. 3	14	7	28	36	2.3
Special[3/]	7	6	35	38	2.3

1/ Volume of dry veneer measured in rough panel units 48 by 96 inches.

2/ Determined by dividing veneer volume by net log scale.

3/ No. 2 Sawmill logs, 18 through 23 inches, meeting requirements of at least No. 3 peeler, except for size.

The Forest Service wanted to test this machine, as many of the national forests have large volumes of timber on topography considered inoperable by present logging methods. This inoperable timber is not at present included in allowable-cut computations. Therefore, if some economical logging method could be developed for these areas, the allowable cuts could be increased, bringing more revenue to the Government, furnishing additional employment, and adding to the industrial raw-material supply.

In 1954, a 7-million-board-foot experimental sale was made to Wyssen. The sale area, 1,000 acres in size, is located in the Jack Creek drainage 10 miles east of Twisp. To log this area by the Wyssen system required 1 mile of road, a tenth of the mileage that would have been needed if an attempt had been made to tractor-log the area. Eighteen strips producing about 3 million board-feet have now been logged. All have been approximately 500 feet wide and have varied in length from 2,000 to 3,500 feet. Difference in elevation from the landing along the road to the power unit on the ridge top is around 1,500 feet. Logging costs for the 3 million feet amounted to $18.40 per thousand board-feet. Included in this cost were felling, bucking, yarding, taxes, depreciation, slash disposal, and overhead. Loading and hauling were not included as the logs were sold at the landing to a local company. These costs are fairly comparable to those of tractor yarding in that area.

Wyssen found from experience gained in the Twisp operation that the present machine was not entirely suitable for American conditions. The output per man-hour and load capacity were both too low and the loading and unloading systems were unsatisfactory. Therefore, his company designed and tested a new model to overcome these shortcomings. The new automatic carriage does not need a separate stop device with anchorage cable. The stop device is built into the carriage and operated by a time release. The loaded or empty hook can be lowered or lifted at chosen points along the skyline.

This new machine is capable of handling 5-ton loads. It is estimated that a 5-man crew, clear cutting in a stand of 40 thousand board-foot per acre, will be able to yard 5 to 6 thousand board-feet per hour.

Skyline cranes suitable for logging the smallest to the largest timber found in the West will soon be available. Machines of this

type undoubtedly will gain in favor as logging moves into the more mountainous country, where road costs are higher and soil-erosion problems more critical.

DEGRADE STUDIES

It is difficult for lumber manufacturers to determine the entire cost per thousand board-feet for putting lumber through a dry kiln and surfacing it. Capital investment and operating costs for the kilns and planing-mill equipment are regularly included in the cost of producing lumber. The cost of producing steam for heating the kilns is also included. There are, however, other seasoning costs that are less obvious and more difficult to determine. These are costs due to degrade. Degrade is the lowering in lumber grade and volume that takes place during the drying and surfacing operations. Lumber shrinks as it dries, building up stresses that tend to make the lumber check, warp, and split. Also, stains may develop and knots become loose during seasoning operations. All of these defects affect both quality and final volume of the seasoned and surfaced lumber and must be accounted for in establishing costs. Little factual data are available on seasoning degrade. Therefore, in conjunction with a ponderosa pine lumber-recovery study made in 1955, detailed information was obtained on degrade.

Three hundred and twenty-two thousand board-feet of lumber was followed from the mill through the kiln and planer. Every board was marked on the green chain with its potential grade. After this lumber had been kiln dried, it was sorted by size and green-chain grade. It was then surfaced and again graded and tallied. Degrade, as expected, was highest in the upper grades of lumber. Sixty-two percent of the B and Better 6/4-inch lumber remained on-grade, with the balance falling into lower grades. Surface checking was the major seasoning defect. Eighty-nine percent of the D Select 6/4-inch remained on-grade. Degrade was considerably less in the common lumber. For example, 95 percent of the No. 5 Common remained on-grade with the other 5 percent being cull and trim loss.

LAMINATING

Periodic inspection of four bridges constructed with glued-laminated structural beams and arches of Douglas-fir showed that the glue bonds were maintaining strong, dependable joints. The glue

Creosote-treated glued laminated arches support this bridge across Culp Creek in Oregon. Installed in 1948, the bridge shows no signs of failure.

used in fabricating the laminated members is of the resorcinol type, considered to be the only practical adhesive for exterior use. The oldest of these bridges is ten years old.

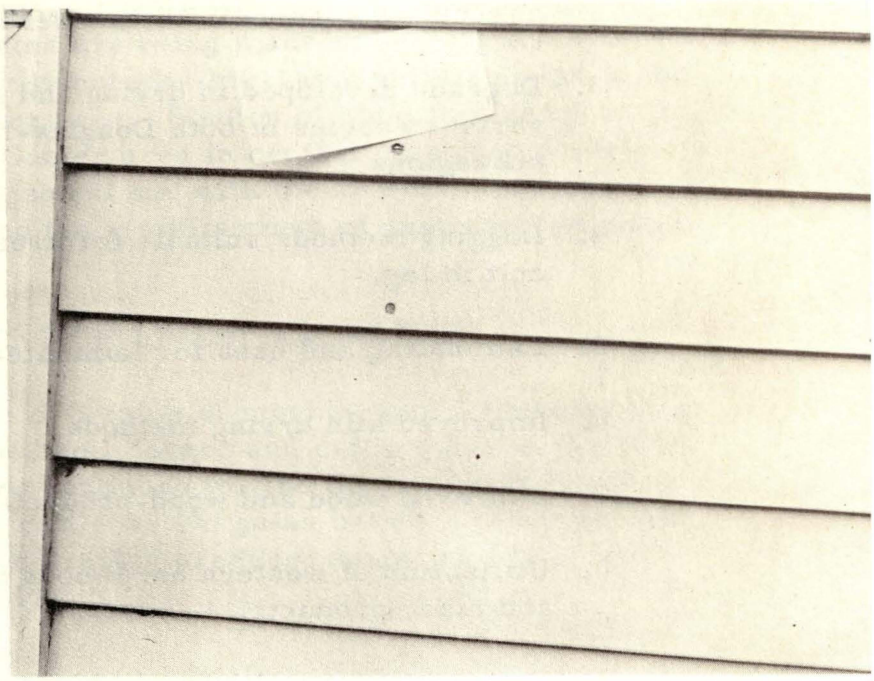
COST OF HAULING LOGS

In 1947 the station released a report entitled, "Cost of Hauling Logs by Motor Truck and Trailer," by J. J. Byrne, Roger J. Nelson, and Paul H. Googins. The supply of this publication was exhausted and there were still numerous demands for the information. It was therefore decided to make additions to the report and reissue it. During the year this work was completed and the revised publication is now available.

SEASONING

A one-week course in kiln drying lumber of western species was again conducted at Corvallis in cooperation with Oregon Forest Products Laboratory. This course is offered each year to train new men in the behavior of lumber as it dries, and in the proper methods of operating dry kilns to realize the best values and utilization of the lumber. Each year between 25 and 35 enrollees attend the course.

Assistance was also given to a number of dry-kiln operators in analyzing causes and remedies for practical problems of kiln operation. Most of this assistance was given through the medium of dry-kiln clubs, while some additional problems were studied at individual plants.



Performance of paint on house siding in the Pacific Northwest is often affected by outside moisture. A, Paint failure where water was permitted to reach back of siding. B, Failure is avoided when siding is treated with a water-repellent primer to eliminate water movement to back of boards. This siding has been exposed to weather for 3 years.

PERFORMANCE OF HOUSE PAINTS

The technique developed by the U. S. Forest Products Laboratory of applying wood sealer on house siding prior to painting appears to hold much promise in minimizing paint failures. During the year a number of house-paint jobs were set up to demonstrate the potential value of this technique in the Pacific Northwest. While only a beginning has been made in the program, results to date show that priming greatly reduces paint blistering and peeling.

PLANS FOR 1957

Most of the projects in the Utilization Division are of a continuing nature. Therefore, the work in 1957 will be much the same as in the past. Close relationships will be maintained between industry, U. S. Forest Products Laboratory, Oregon Forest Products Laboratory, and other institutions doing research work on wood utilization. Major emphasis will be given the following projects:

1. End-product timber appraisal-base study.

2. Lumber grade recovery studies for ponderosa pine and associated species in the ponderosa pine subregion.

3. Degrade developed in drying and surfacing lumber of various species of both Douglas-fir and ponderosa pine subregions.

4. Logging methods suitable for areas now considered difficult to log.

5. Laminating and uses for laminated products.

6. Improved kiln drying methods.

7. Improved wood and wood-products containers.

8. Utilization of western hardwoods for pulp, lumber, veneer, and other products.

9. Exterior paint and paint problems in the Pacific Northwest.

RANGE MANAGEMENT RESEARCH

Highlights of the year were the addition of game-habitat research to the range-investigation program and the initiation of new grazing studies on livestock ranges.

Big-game habitat studies are now in progress or will soon be started on both deer and elk ranges in Oregon and Washington. Grazing management studies are being made in central and southern Oregon, with emphasis on livestock--big-game relationships in the Deschutes Research Center area. Studies of big-game range in the Mid-Columbia Research Center area in central Washington are concerned with habitat management and with the relation of site factors to seedbed preparation and the establishment of game-forage plants on low-capacity ranges.

MANAGEMENT OF LIVESTOCK RANGES

The study of effects of 3 rates of stocking and 2 systems of management on vegetation, soil cover, and cattle gains in the Blue Mountain Research Center continued for the third year of the 10-year plan. Variations in cattle weight gains between years became more apparent. Moderate grazing produced more pounds of beef than heavy grazing in 1956.

Cattle Weight Gains

Gains of calves were almost identical to 1955 gains (table 4). Heavy grazing produced average weight gains of 179 pounds for calves, as compared with 197 pounds for moderate grazing. Calves on lightly grazed pastures gained an average of 206 pounds during the 107-day grazing season. As in 1955, there was no significant difference between calf gains under season-long and deferred-rotation systems of management.

Gains of cows were substantially smaller than in 1955 (table 5). Cows under heavy grazing gained the least, 29 pounds, while light and moderate grazing produced average gains of 57 and 58

Table 4. --Weight gains of calves on ponderosa pine summer range during 1955 and 1956

Grazing intensity 1/	1955			1956		
	Deferred-rotation	Season-long	Average	Deferred-rotation	Season-long	Average
	Pounds					
Light	206	209	208	203	209	206
Moderate	192	200	196	199	196	197
Heavy	176	185	180	177	182	179
Average (wtd.)	189	196	193	191	194	192

1/ Light: 10 acres per head per month; moderate: 7-1/2 acres per head per month; heavy: 5 acres per head per month.

pounds, respectively. The decreased gains in 1956 may be associated with quality of forage during the latter part of the grazing season. In 1955, rainfall in late July extended the green-forage period well into August. Early in September, several storms provided sufficient moisture for substantial regrowth of Sandberg bluegrass (Poa secunda) and bluebunch wheatgrass (Agropyron spicatum) on grassland openings. When the cattle were weighed in early October, they were taken off green feed. In 1956 the last effective rainfall was in mid-June, and forage on the grasslands was dry by late July. Rainfall during August and September was not sufficient to start grass regrowth. The dry grass with its lower crude-protein content perhaps was a major contributing factor to the lower gains of cows in 1956.

Moderate stocking produced more pounds of beef than heavy stocking after two years of stocking at each level. In 1956 total

Table 5.--Weight gains of cows on ponderosa pine summer ranges during 1955 and 1956

Grazing intensity 1/	1955			1956		
	Deferred-rotation	Season-long	Average	Deferred-rotation	Season-long	Average
	Pounds					
Light	87	87	87	57	56	57
Moderate	74	73	74	51	65	58
Heavy	43	68	55	18	40	29
Average (wtd.)	64	74	70	39	53	46

1/ Light: 10 acres per head per month; moderate: 7-1/2 acres per head per month; heavy: 5 acres per head per month.

gain of 81 cows and calves under moderate stocking was 20,655 pounds compared with 20,384 pounds gained by 98 cows and calves under heavy stocking. In 1955, the first year of the study, total gains under heavy grazing were 1,302 pounds more than under moderate stocking.

Control of Cattle Distribution

Initial research in grazing management on the Deschutes National Forest included investigation of water-hauling practices to obtain more efficient forage use and livestock distribution. Various range types were reconnoitered to locate areas for development of range condition and trend criteria and for evaluation of the economics, effectiveness, and influence of water hauling on livestock movements and range forage in central Oregon.

Average cost of water hauling for three livestock owners was $1 per head per month for cattle. One owner figured the cost of the operation for sheep at 25¢ per head per month. If water hauling was not practiced, one operator who owns 250 brood cows could maintain no more than 100 cows.

The effect of water hauling on cattle distribution and range forage depends largely on the class of animal. Where dairy breeding stock is used, definite zonation of forage use exists. Areas around water tanks, in place for three years, are completely bare for 100 feet. All forage within 500 feet of the tank is very heavily used. Forage use tapers off to about 3/4 mile from water, beyond where little or no use occurs. Where pure range breeds are used--Hereford or Angus cattle--little zonation of forage use exists.

USE OF FIRE FOR RANGE IMPROVEMENT

Range management value of prescribed burning for jungled-up ponderosa pine range has become more apparent from a study conducted on the Colville Indian Reservation. However, some important limitations must be attached to the practice of burning.

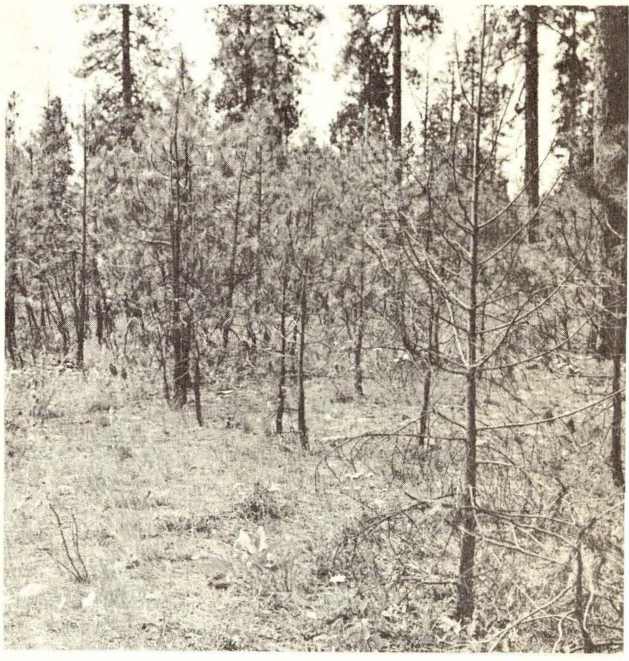
The direct benefit of improved accessibility for domestic livestock was delayed three grazing seasons after treatment since most of the fire-killed tree reproduction remained standing for that period. Possible benefits for big game were not delayed. During all four grazing seasons since the burn, the treated area has provided increased amounts of herbaceous plants and an abundance of tender new shoots from sprouting shrubs.

By the fourth grazing season after the burn, the "jungle" problem with tree stems was about over. Also, the flush of growth by broad-leaved herbs had subsided considerably. Grasses, principally pinegrass, retained more of their gains than broad-leaved herbs, yet appeared to be yielding to competition from shrubs. At the end of the fourth season, shrubs had reached densities nearly equal to those before the burn.

No relationship between reduction in amount of tree reproduction and increase in density of herbaceous plants could be demonstrated. A correlation was found between the first-year decreases in shrubs and increases in herbaceous plants. However, this relationship may be only partial, or one of coincidence, since the

Use of fire in range improvement.

A, "Jungled-up" tree reproduction (ponderosa pine) before prescribed burning treatment.



B, Fire-killed reproduction still standing, first growing season after prescribed burn (July 1953).

C, By fourth growing season after prescribed burn, "jungle" problem with tree stems was about over (July 1956).

increased availability of nitrogen after the fire could also explain the flush of herbaceous growth. The most rapid shifts of herbaceous and shrubby vegetation since the burn appear to be over.

EFFECTS OF LOGGING ON FORAGE

Observations on early stages of herbaceous and shrubby succession following logging of ponderosa pine stands are now complete. Recovery of understory vegetation has been followed for seven years in a study conducted in eastern Oregon and eastern Washington.

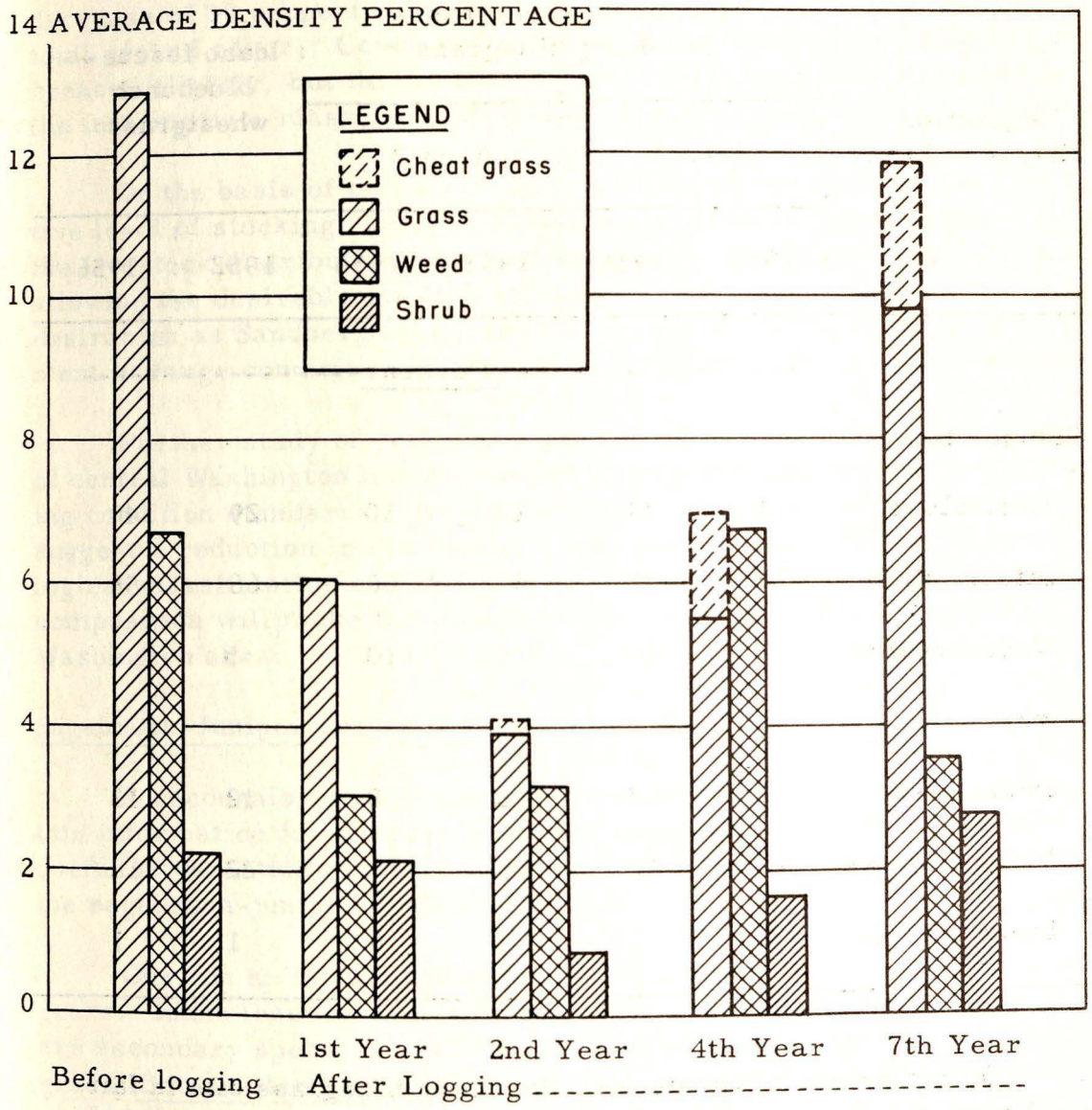
The study shows a major turning point between the fourth and seventh years following logging. Restoration of total plant coverage was attained by the fourth year, but the flush of growth was predominantly one of broad-leaved herbs. After the fourth year, amount of broad-leaved herbs started to decline. Grasses, which were reduced most by logging, continued their slow but steady march toward regaining their former status in the plant cover. Shrubs also approached their former abundance by the seventh year.

Plots completely denuded by skid trails have recovered more slowly than plots that were subjected to less logging disturbance. Forty-five percent of the denuded plots failed to regain their pre-logging ground cover by the seventh year after logging. Furthermore, the vegetation is predominantly weedy. In eastern Washington, vegetation averaged 32 percent cheatgrass. Annuals, undesirable perennials, and noxious plants obtained a toe-hold on the compacted and denuded plots by the second year after logging. Since that time, these plots have not been favorable seedbeds or growing sites for any plants other than undesirable species, particularly those which propagate vegetatively.

RANGE CONDITION AND TREND

Ponderosa Pine Grasslands

Remeasurement of 9 Parker 3-step transects on 3 grassland sites on the Starkey Experimental Forest and Range shows that the method provides a measure of changes in range condition. The quality of the forage has improved on the sites studied during the 1952-56 period (table 6).



Average density of understory vegetation before and after logging of ponderosa pine range in eastern Washington.

Table 6.--Composition and cover of three grassland sites in eastern Washington, 1952 and 1956

Vegetation characteristics	Bluebunch wheatgrass-Sandberg bluegrass				Idaho fescue-bluebunch wheatgrass	
	Area 1		Area 2			
	1952	1956	1952	1956	1952	1956
	Percent					
Composition:						
Desirables	6	11	24	30	29	40
Intermediates	77	79	67	60	66	56
Undesirables	17	10	9	10	5	4
Cover:						
Desirables	1	3	6	8	12	13
Intermediates	13	10	16	14	22	18
Undesirables	2	1	0	0	1	1

On a bluebunch wheatgrass-Sandberg bluegrass site in fair condition, the composition of bluebunch wheatgrass increased from 6 to 11 percent. Sandberg bluegrass decreased 7 percent during the same period. On a similar site, composition of bluebunch wheatgrass increased from 24 to 30 percent while Sandberg bluegrass decreased 20 percent. The Sandberg bluegrass has been replaced in part by bluebunch wheatgrass and by climax perennial forbs.

On an Idaho fescue-bluebunch wheatgrass site in good condition, the improvement was due to an increase in composition of Idaho fescue (Festuca idahoensis) and prairie junegrass (Koeleria cristata). These species increased 66 and 36 percent, respectively, during the four-year period. Again, Sandberg bluegrass showed a decrease of 30 percent. In general, there has been little change in total ground cover. Cover provided by desirable species has increased slightly, but this has been offset by a reduction in cover in the intermediate class, largely Sandberg bluegrass.

On the basis of these results, it is apparent that the conservative level of stocking, deferred-rotation system of management, and the livestock distribution program currently in effect at Starkey are allowing the desirable species to compete with and replace such less desirables as Sandberg bluegrass. The net result is an improvement in range condition and higher quality, more dependable forage.

Further study of ponderosa pine ranges in the Cascade Range of central Washington has shown the need for modification of existing condition standards. New data obtained by the 3-step method suggest a reduction in the forage basal area index. Shifts in ecological classification and more specific categories for floristic composition will make the standards more usable in the central Washington area.

Sagebrush-Juniper Grasslands

A reconnaissance in central Oregon was made in 1956 to obtain information for a range problem analysis. Two relict areas, useful as yardsticks in condition and trend studies, were located in the sagebrush-juniper-grass type.

One, on an isolated plateau, is dominated by bluebunch wheatgrass. Idaho fescue, prairie junegrass, and needlegrass (Stipa sp.) are secondary species. Very little Sandberg bluegrass and cheatgrass (Bromus tectorum) is present. Livestock probably have not grazed this area in the past 30 years.

The other area is located on a moderate northeast slope. Plants associated with sagebrush-grass and sagebrush-grass-juniper are intermingled. Bluebunch wheatgrass, Idaho fescue, Indian ricegrass (Oryzopsis hymenoides) and threadleaf sedge (Carex filifolia) occur in equal abundance. Various shrubs common

to both range types also exist. Topography and absence of watering facilities have resulted in absence of grazing in this area.

Subalpine Ranges

The subalpine, green-fescue sheep range in the Tenderfoot Basin, Wallowa Mountains, initially studied and reported on by G. D. Pickford and E. H. Reid in 1938, was partially remeasured and rephotographed in 1956. A comparison with the initial data and photographs shows that the majority of the area improved greatly during the 18-year period as a result of improved herding and range-management practices.

Erosion was severe in 1938 because of excessive trailing and overgrazing. Seventy to 90 percent of the conspicuous green fescue stools were dead and supported other perennial and annual weeds. Green fescue, needlegrasses, and sedges were producing only 350 to 500 pounds of herbage per acre. At present, the stools are becoming stabilized, bare areas are partially revegetated, accelerated erosion is not evident, and the same species are producing 1,500 to 2,000 pounds of green herbage per acre. Recovery of the climax green fescue has proceeded faster where more of the top soil remained.

Where top soil had been completely removed prior to 1938, recovery has been considerably slower. Green fescue range that was classified as the second weed stage in 1938 has changed to a mixed grass-and-weed stage. Needlegrass, sedges, and bottlebrush squirrel-tail (Sitanion hystrix) are now predominant on sites where Nuttall gilia (Gilia nuttalli), Rydberg penstemon (Penstemon rydbergi), and nettleleaf gianthyssop (Agastache urticifolia) were the most abundant species in 1938.

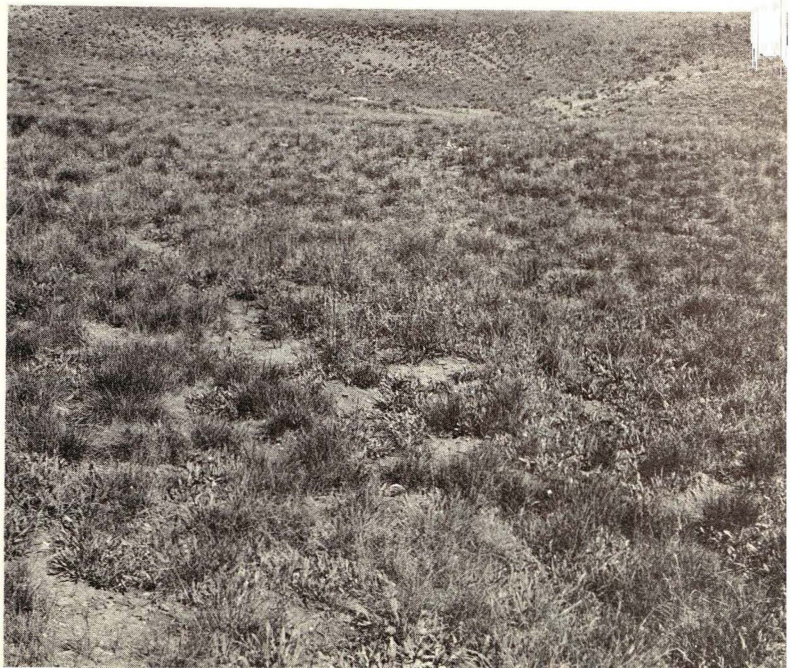
The damage that improper management can cause was clearly shown on a site classed in excellent condition in 1938. Owing to a misunderstanding, the site was used as an area bedground for 2 years following the study. Although the fescue and needlegrasses have recovered to their original stand, 15 percent of the present composition is Erigeron spp., which was not present in 1938.

Further investigation of green fescue ranges in the Cascade Range of central Washington indicates that standards prepared in 1955 for the northern Cascades are applicable to some of the

subalpine grasslands as far south, perhaps, as Mt. Stuart. South of this, or at least at those altitudes where soils are residue from basalt, a different condition standard will be necessary. A standard for these areas in southern Washington will have to include needlegrasses (Stipa spp.).

ECOLOGY OF ELK SEDGE

Clipping of individual plants has significantly reduced the vigor of elk sedge on the Starkey Experimental Forest and Range. This reduction is independent of the date of harvest.



A subalpine, green-fescue sheep range area in the Wallowa Mountains. A, in second weed stage. Principal species are Rydberg penstemon and Nuttall gilia. Erosion pavement on 50 to 75 percent of the soil surface. (1938.) B, Areas formerly occupied by weeds now support a stand of needlegrass and sedges. Note the extent of healing on erosion pavement on slope in background. (1956.)

Loss of vigor has been measured by seed-stalk production, considering both numbers and heights. Half as many seed stalks were produced in 1956 as a result of 60-percent herbage removal the previous year, compared with the average effects of 20- and 40-percent harvests. Heights of seed stalks are significantly less under the 60-percent harvest. No significant differences in heights and numbers occurred between the 20- and 40-percent harvests. Approximately 60-percent use of elk sedge, regardless of when it occurs, is too heavy for the plant.

Third-year results show no significant differences in the herbage production of elk sedge under three intensities of herbage removal at four dates during the grazing season.

MANAGEMENT OF BIG-GAME RANGES

Funds for big-game habitat studies were made available July 1. Recruitment of game specialists and necessary shifts in personnel were completed by September. The remaining time in the year was devoted to reorientation of the range-research program, development of project analyses, and beginning of exploratory studies at three research centers.

In the central Oregon area, serviced by the Deschutes Research Center, 18 major deer herds are recognized. Winter ranges for many of these herds are in critical condition. Utilization of bitterbrush is as high as 80 percent on some of these ranges, and 100-percent use of individual plants is not uncommon. The resulting effect is depletion of winter-range areas.

In one area, deer are severely abusing a summer range, but in other areas the range is only slightly used. Research is needed to determine the factors underlying these different degrees of use. Other studies of high priority include development of condition-and-trend standards for deer winter ranges, determination of forage preferences by deer during various seasons, site differences and site potentials for bitterbrush, and compatibility of livestock and big game on spring-fall and winter ranges.

Areas of direct competition between livestock and big game for common forage plants exist in central Oregon and elsewhere. Predominantly these areas occur on common summer range or range used by livestock in the summer and fall and by deer in the fall and winter. Cattle begin concentrated use of bitterbrush in

mid-August. In some cases, the plant receives its full degree of use before deer move into the area in the fall. In one area, cattle use on bitterbrush by October 1 has consistently been between 40 and 50 percent for the past 5 years. Additional use results in depleted bitterbrush ranges.

A study to determine the effectiveness of various deer-repellent chemicals on ponderosa pine seedlings in central Oregon was initiated during the year in cooperation with the U. S. Fish and Wildlife Service. Three chemicals, ZAC, TMTD, and TNT mixed with Rhoplex adhesive, were used. Three concentrations of TMTD and one concentration each of ZAC and TNT were used. Effectiveness of these chemicals will be determined by height measurement of pine seedlings.

Forage Utilization by Big Game

The initial inventory of herbage composition and production was made on another big-game pasture at the Starkey Experimental Forest and Range. Utilization studies show little or no use of grass or grasslike species by deer and elk during the summer grazing season.

Analysis of pellet-group counts in the experimental pastures show considerable variation in game use from year to year. Use by deer varied from 54.2 animal-unit months in 1953 to a high of 400 animal-unit months in 1955. In 1956, use by deer was 58.5 animal-unit months. The fluctuation in game use is probably due more to length of the grazing season by game than to changes in population. The years of greatest use by game correspond to winters with a relatively light snowpack when deer undoubtedly remain in the area during the entire winter. Use by elk follows the same general pattern, but the variation is not so great. Use by elk varied from a low of 28.3 AUM's in 1953 to a high of 156.4 AUM's in 1955. In 1956, use by elk was 59.7 AUM's. Total use by deer and elk in 1956 was equivalent to 27 percent of the summer use by cattle.

Game-use studies at Starkey provide a measure of spring-fall use by elk, and winter use in the event of an open winter. Deer use is relatively uniform during all seasons. To provide more information on winter use by elk, a study was initiated on elk winter range on the lower Grande Ronde River. An area of approximately 200 acres will be sampled intensively during the 1956-57 winter season to determine which forage species are used and the extent of the use.

Adaptability of Game Forage Species

Pubescent wheatgrass (Agropyron trichophorum) and timothy (Phleum pratense) are presently the most consistently high producers studied in an adaptability trial of game-forage species on the Okanogan National Forest. Other species that by the third year developed a reputation for relatively high production are blue wildrye (Elymus glaucus), mountain brome (Bromus carinatus), and orchard grass (Dactylis glomerata). Intermediate wheatgrass (Agropyron intermedium) and slender wheatgrass (Agropyron pauciflorum) were also rather good producers but not consistently so among blocks within the study area. All of the above species competed well with an infestation of western yarrow (Achillea lanulosa), which is now abundant in less productive plots.

Of the legumes, only ladak and nomad alfalfas have persisted. With protection from deer use during two growing seasons, these only produced dwarf plants. The site lies at almost 6,000 feet elevation and at the rather northerly latitude of 48°, 40'.

Site Factors on Game Ranges

Unsuccessful reseeding attempts sometimes can be turned into assets. It is hoped that such is the case with a seedbed and site-factor study on a high elk range in the Cascade Range in central Washington. Seedbeds treated with various amounts of sawdust and fertilizer were planted by various techniques to intermediate wheatgrass in the fall of 1952. As previously reported the treatments alleviated fertility, frost-heaving, and drought problems. Best germination, emergence, and initial growth occurred on broadcast-and-cover seedings with seedbed amended with heavy applications of sawdust and nitrogen fertilizer. However, expected growth and development of the best grass stands failed to occur during the second growing season. By the third growing season almost none of the intermediate wheatgrass was alive.

Two possible explanations for this rapid stand degeneration have been found to date. First, the soil pH was found to be depressed by heavy applications of ammonium sulphate. Unfertilized plots had an average pH of 5.65 whereas plots treated at the rates of 400 and 800 pounds of nitrogen per acre had average pH values of 5.20 and 4.80, respectively.

The second possible explanation involves species adaptability to the site. Every June, soil of the study area contained cold free-water at a depth of 4 to 6 inches. Source of the water was a snow-bank in an alpine fir thicket on the uphill side of the plots. Even though the plot was usually snow free in late May and all of June, the snowpack in the thicket remained through June and sometimes through the first ten days of July. Subsurface drainage across the study plots created a "wet-foot" condition. Pacific grass bugs also plagued the plantings, but they were kept under control by a leaf-hopper insecticide.

A revised planting trail is contemplated for this type of elk range in 1957 with only one method of seeding, use of a different nitrogen fertilizer, and use of grass species tolerant of "wet-feet" and resistant to grass bugs.

PLANS FOR RESEARCH IN 1957

Emphasis in the 1957 research program will be placed on analysis of game-range habitat problems, preparation of study plans, and initiation of additional research projects in both Oregon and Washington. Special attention will be given to the relationships between game animals and land-management practices on forest and related ranges. Continued emphasis will be placed on preparation and revision of condition-and-trend standards for both livestock and big-game range.

Range problem analyses for the Blue Mountain and Mid-Columbia Research Centers will be completed. Three sections will be added to the problem analysis being prepared at the Deschutes Research Center: (1) grazing management of livestock ranges, including both seeded and natural ranges; (2) grazing management of big-game ranges; and (3) big-game--livestock relationships.

At the Starkey Experimental Forest and Range the first reinventory of herbage composition and production will be made after 3 years of grazing treatment at 3 intensities and 2 systems of management. On subalpine ranges an inventory will be completed of 563 plots established in 1938 in Tenderfoot Basin, Wallowa National Forest. Utilization studies on summer game range will be intensified and new utilization studies on game winter range will be initiated. Arrangements have been made with the Soil Conservation Service for a soil survey on the experimental pastures and watersheds

at Starkey. This survey will provide a better basis for interpreting results from grazing-management and erosion studies.

At the Mid-Columbia Research Center new studies will be established on deer and elk ranges in the Cascade Range. Also, national-forest officers will be assisted in determining game-livestock relationships in connection with range allotment analyses now in progress.

WATERSHED MANAGEMENT RESEARCH

Watershed research activities in Oregon and Washington stepped up considerably during the year. The Station's program expanded into the area served by the Siskiyou-Cascade Research Center of southwest Oregon, the fourth research province in the Pacific Northwest to receive attention. At the same time, work in the other three areas continued to progress. The program is still largely in the planning stage but some specific studies have been started that promise to give early results.

CORVALLIS WATERSHED STUDIES

The Corvallis (Oreg.) Watershed is similar to many municipal watersheds in the Northwest and represents a typical problem in multiple-use management. Until recently the forest cover, mostly overmature Douglas-fir, remained undisturbed. In 1951 a severe windstorm followed by a Douglas-fir bark beetle epidemic left 60 million board-feet of dead timber. In 1953 logging was begun to salvage some of the loss and to reduce the serious fire hazard created by concentrations of dead material.

In 1955 a study of soils was undertaken, in cooperation with the Forest Experiment Station, Oregon State College, on three selected clear-cut units in the watershed. The object was to examine some of the physical properties of these soils following disturbance by logging and slash burning. Four surface conditions were sampled in each unit: lightly burned, severely burned, disturbed-unburned, and undisturbed. A fifth condition was represented by samples taken in uncut timber adjacent to each unit. Each sample was tested for ability to retain moisture and its content of sand, silt, clay, organic matter, and water-stable aggregates.

Surface conditions classified as undisturbed, disturbed-unburned and lightly burned made up 92 percent of the area in the cutover units. Physical properties of soils in all three conditions were essentially the same and furthermore did not differ significantly from those measured in adjacent timber.

Soil samples from severely burned surfaces, however, showed marked differences. This classification covers the remaining 8 percent of the cutover areas, represented by scattered patches where all litter had been removed and the mineral soil baked red by the fire. Distinct differences in the proportions of silt and silt-plus-clay resulted in the upper layers of severely burned soil on 2 of the 3 clear-cut units. Significant reductions in organic matter, total soil aggregation, and ability to retain moisture occurred on all three units.

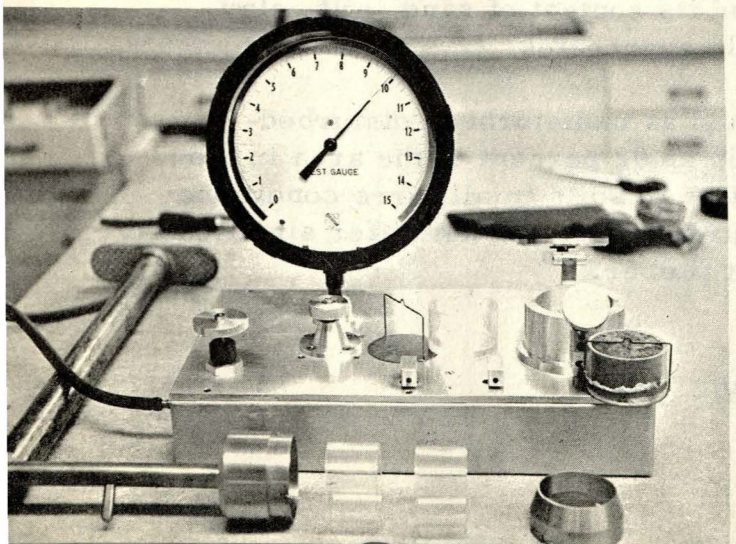
SOIL SECRETS STUDIED

Problems concerning soil stability and erosion have long been vexing to land managers. Information about forest and range soils is scarce and lack of skills to apply the little information available has allowed many erosion problem areas to develop.

The Mid-Columbia Center, headquartered at Wenatchee, Wash., has made significant gains in attacking this important phase of wild-land management during the year. Maps prepared by the Forest Service to show surface geology and land form on national forests are being used as a base for much of this work.

One of the first projects has been a tentative erosion-hazard index for soils. Ten classes of erosiveness were developed, based on parent material and topographic land form. Vegetation, aspect, and land treatment are additional factors that have not yet been considered, and their importance necessitates an early attempt to evaluate them.

A laboratory is being equipped for use in investigating soil properties. First effort will be to isolate the chemical and physical properties related to erosiveness. These properties will then be



This air pycnometer was designed to determine soil pore space and moisture storage capacity. Samples of undisturbed soil are taken in lucite rings by the metal sampler in the foreground. Sample and ring are placed in the pycnometer chamber at the right and the reading on the gage converted to percent pore space.

studied to determine if they can be altered by land management practices to improve soil stability.

Two special pieces of equipment were designed to facilitate soil studies. One is an air pycnometer, which will greatly expedite the determination of soil pore space and moisture storage capacity. The other is designed to determine the degree of cohesion between soil particles, one of the important properties relating to erosiveness.

EFFECT OF TIMBER COVER ON STREAMFLOW

Shortages of late-summer irrigation water are common in many of the major Blue Mountain drainages of northeast Oregon and southeast Washington. To evaluate effects of timber management on streamflow, two experimental watersheds were chosen on McCoy Creek, a tributary of the Grande Ronde River. Stream gages will be installed in each of these watersheds, and various cutting methods will be tested to determine their effects on timing and quantity of runoff.

Predominating timber type on the test watersheds is lodgepole pine. Sample plots show that the stands vary from 360 to over 2,000 stems per acre, averaging around 1,100. Basal area ranges from 80 to over 200 square feet per acre, averaging around 150. Ground cover by perennial forbs, shrubs, and grasses varies from 24 to 56 percent. Soil not supporting perennial growth is covered by litter.

Soil on which lodgepole pine is found in the watersheds is typical of that associated with this timber type in the Blue Mountains. It is a heavy-textured product of basalt, overlain by varying depths of a floury, wind-transported pumice. Total soil depth ranges from 40 to 84 inches. Of this, the residual basalt soil averages around 36 inches in depth and the pumice averages 22 inches.

Surface pumice, which may vary from a few inches to over 3 feet in depth, is highly permeable and readily absorbs large amounts of water. The underlying residual soil, while having a high water-holding capacity, is quite impermeable. Temporary water tables form in the pumice on top of the residual soil during the snow-melting period, and seeps occur where the pumice is shallow. There is very little surface runoff on these soils.

SNOW MANAGEMENT IN LODGEPOLE PINE

A survey of lodgepole pine stands of the Blue Mountains during the summer disclosed characteristics important to watershed relations. While the stands may be heavily overstocked (with as many as 15,000 stems per acre), a surprising amount of light penetrates the canopy. In these heavily stocked stands, as well as in stands considerably less dense, crown length is seldom over 30 percent of stem length. These short crowns probably also permit a relatively large amount of precipitation to reach the ground compared with the mixed-conifer type that occurs on similar sites in the region. This characteristic of the crown canopy is also associated with a fairly dense ground cover of perennials.

A block of cutting plots has been established in the Grande Ronde drainage to determine if lodgepole can be harvested in such a way that more snow will accumulate and melting will be delayed. For this purpose, the following four patterns of clear cutting lodgepole pine will be tested: (1) strips one chain wide, (2) strips two chains wide, (3) circles one chain in diameter, and (4) circles two chains in diameter. On half the cut area, slash will be left as it lies; on the other half, it will be lopped and scattered. Effects of cutting on soil moisture and precipitation interception will be measured throughout the year. A series of snow courses will be used to measure snow accumulation and melt.

EROSION FROM GRAZING

Light, moderate, and heavy grazing by cattle are being studied at Starkey Experimental Forest and Range in northeast Oregon. Purpose of the studies is to determine how these intensities of use affect range erosion. Most of the surface runoff in the pastures is from open grasslands, which are usually characterized by shallow, heavy, basalt soil. During the summer this soil dries and shrinks, leaving large cracks. Very little summer surface runoff occurs, because summer storms are rarely of higher intensity than the dried soil can absorb and hold. From late fall to late spring, however, these shallow soils are usually saturated. As a result, most of the surface runoff--and erosion--occurs during the snow-melting period.

BULL RUN WATERSHED STUDY

Late in 1955, the Forest Service and the City of Portland signed a contract providing for a cooperative study in the Bull Run Watershed. Primary objective is to develop methods that will lead to sound management of this important municipal water supply area.

During the past year, satisfactory progress was made in both preliminary planning and field accomplishment. After deciding that the first task was to determine characteristics of runoff and its relation to timber cover, a reconnaissance was made of all sites suitable for this type of study. A final selection was made of three small watersheds located near the south boundary of the main Bull Run Watershed.

A concrete and metal trapezoidal mountain flume, complete with gaging house and recording instruments, was installed at the first site and is now yielding useful runoff data. Precipitation data are also being collected near the site in a continuously recording catchment gage.

Rainfall and snowfall in the Portland municipal watershed are measured by means of a gage installed on a 15-foot tower. A shield surrounds the gage opening to reduce wind velocities and therefore insure a more accurate record of precipitation. (Photo by Al Monner.)

PLANS FOR 1957

1. Develop the watershed research program in the Siskiyou-Cascade Research Center Province.

2. Analyze samples of major soil types in the Mid-Columbia Province as these are encountered in the course of watershed studies.

3. Complete plans for gaging experimental watersheds in the mixed-conifer timber type of the Mid-Columbia Province.

4. Collect first-year data on snow storage and melt in lodgepole pine and install a second block of plots for this purpose in the Blue Mountain Province.

5. Begin a study at the Starkey Experimental Forest and Range to determine the relation between cattle grazing and runoff.

6. Prepare plans for erosion control studies in connection with a proposed timber sale on a portion of the Starkey Experimental Forest and Range.

7. Complete the remaining two installations on experimental watersheds in the Bull Run watershed.

AERIAL-SURVEY TECHNIQUES RESEARCH

In the fall of 1956, all aerial-survey techniques work was consolidated into a research project. A team of technical men was assigned to undertake studies designed to solve some of the problems in this field. Results of the work will be useful in several branches of research and in the management of both public and private timberlands throughout the West.

The project is staffed by three foresters, representing the divisions of Forest Economics Research and Forest Insect Research of the Experiment Station, and the Timber Management Division, Region 6. An additional man is assigned to the project as aerial photographer and darkroom technician. Available equipment includes an airplane, several aerial cameras, and facilities for processing color as well as black-and-white film.

Most of the work done in 1956 was a continuation of studies that were under way in the divisions of Forest Economics Research and Forest Insect Research before the consolidation took place. These studies soon will be either completed or incorporated as parts of the new program. Long-range research plans are now being made and coordinated with those of other workers in the United States and Canada. Work will be concentrated in the fields of insect-damage evaluation, forest survey, and working-circle inventory, but problems in other fields will be considered as opportunities arise. Many of the principles and techniques developed should be applicable to other regions.

INSECT DAMAGE EVALUATION

Bark Beetles

Work was continued on aerial-photo methods of evaluating mortality caused by the major bark beetles. Studies were aimed at increasing the accuracy of photo interpretation. Previous investigation has shown that mortality caused by epidemics of the Douglas-fir bark beetle or the western pine beetle can be assessed by a

combination of photo interpretation and field work more economically than by a field survey alone. However, before trends of annual mortality under endemic as well as epidemic conditions can be evaluated, interpretation accuracy must be improved.

The 1956 studies tested interpretation accuracy for two successive years of photography. Previous tests of the technique used have been confined to single photographic flights. Under these conditions it is often difficult to distinguish a tree that died in the past year--i.e., current mortality--from one that died the previous year. If photographs of the same area taken a year earlier were available, then this type of error should be reduced. To test this idea, aerial photos covering areas that had previously been photographed and field checked were taken with panchromatic, color, and camouflage-detection films. Interpretation and analysis has not been completed.

A pilot test of the aerial-photographic method, using a single flight of photos, was made on 6,000 acres of ponderosa pine type in the Los Padres National Forest, Calif. In this test, the method was not successful; the interpreters were unable to correctly identify the current ponderosa pine mortality on 1:5,000-scale panchromatic photographs. Evaluation of mortality in this area was complicated by the presence of other tree-killing insects and by a fire that had run through part of the area several years ago.

Balsam Woolly Aphid

An exploratory test was made to determine the accuracy of evaluating on aerial photographs, damage to Pacific silver fir by the balsam woolly aphid. Photographs may prove of particular value here because field assessment of the damage requires a lengthy inspection of each tree crown with binoculars. Preliminary results indicate that it is possible to recognize several degrees of damage on large-scale color or camouflage-detection photos. In the initial test, a series of individual trees were classified into essentially the same damage categories on the photos as in the field. If additional tests on a more extensive basis are equally successful, photographic evaluation of this damage should prove more economical than field evaluation.

FOREST INVENTORY TECHNIQUES

Large-scale Aerial Photographs

A preliminary investigation of the possibilities of using large-scale aerial photographs in forest inventory work was begun in the fall. Purposes of the study are: to explore some of the problems of taking large-scale photographs, to determine whether or not the accuracy of interpretation is greater on these than on standard scales, and to determine if any such increase in accuracy is sufficient to pay for having the photos taken on a sample basis for forest inventory purposes.

Several test areas were photographed with color and panchromatic films at scales ranging from 1:10,000 to 1:500, and a preliminary assessment has been made of some of the major problems encountered in large-scale aerial photography.

One of the problems encountered at large scales is extreme parallax, which makes the stereo image uncomfortable to view. In mature timber of the Pacific Northwest, a scale of 1:10,000 is about the largest that can be used with a 12-inch lens without encountering objectionable parallax. A 24-inch lens was tested as a solution to this problem, and it gave excellent results with scales as large as 1:2,500.

As photo scales get larger, image motion becomes greater and causes blurred pictures. It is necessary to use the fastest shutter speed available to minimize this. A shutter speed of 1/225, fastest available on many current cameras, is generally sufficient to produce usable photos at scales as large as 1:2,000. Beyond this, faster shutters or some form of image motion compensation is necessary. A film magazine that compensates for image motion was tested and found to produce satisfactory photos at scales as large as 1:200.

As large-scale photography requires rapid camera recycling, some cameras may have to be speeded up. The station's K-17B aerial camera was changed from a 4-second cycle to a 1-second cycle by increasing the gear ratio and enlarging the vacuum vent in the drive case.

Rough air is often encountered at the low altitudes required by large photo scales. The use of a 24-inch lens helps by increasing

Examples of the range of photo scales being studied for possible forestry use in the Pacific Northwest. A, 1:10,000 scale. The largest scale commonly used for forest inventory work in this region is 1:12,000. B, 1:500 scale, showing part of the area in the photo above. Large-scale photos such as this are being tested for use in regeneration surveys.

the flying height required for a given scale. Smoother air is normally found at these higher elevations.

Minor problems encountered are the difficulty of photographing small areas at large scales, and of determining actual photo scale when photographs cover a small area. Solution to the first problem is pilot experience and improved pilot visibility. Possible solutions to the latter problem are use of a radio altimeter, or dual camera photography with small- as well as large-scale photos.

Test photographs are now being interpreted to assess accuracy obtainable on the various scales. Factors being tested are: species identification; measurement of tree heights, crown diameters, and crown closure; tree counts; and stocking condition on logged areas and burns.

Pine Understory Typing

A study was begun during the year to determine if the understory of ponderosa pine stands can be mapped from aerial photographs with sufficient accuracy to aid in managing the stands on a unit-area basis. Height and density classes were used as criteria for classifying the understory. Preliminary results from a small test area indicate that this information can be obtained from panchromatic photographs at a scale of 1:10,000 or smaller with sufficient accuracy to form the basis for unit-area-control management plans.

PLANS FOR TECHNIQUES RESEARCH IN 1957

Research work on forest-insect survey techniques during 1957 will be aimed at improving the accuracy of photographic mortality and damage evaluation. Current tests of repeat photography will be completed, and additional techniques--such as use of oblique photos, large scales, and long lenses--will be tested.

Research work on forest inventory techniques will follow two major approaches: improvement of type-mapping methods, and improvement of volume estimation from aerial photographs. An effort will be made to develop a forest-type classification scheme that can be correlated with the photos and that will be of more use for forest-management purposes than the present one. Past studies on aerial-photo volume tables will be renewed in an attempt to improve existing tables and develop new ones. Efforts also will be

directed at improving methods of applying these volume tables so that inventory information can be broken down into units such as ownerships and minor geographical subdivisions. Studies will continue on the use of large-scale photos on a sample basis for forest inventory work.

PUBLICATIONS AND ARTICLES

1956

By members of the staff
and cooperators

FOREST PROTECTION

Disease

Childs, Thomas W., and Wright, Ernest
Pruning and occurrence of heart rot in young Douglas-fir. Pacific Northwest Forest and Range Expt. Sta. Res. Note 132, 5 pp. (Processed.)

Pruning does not materially increase heart rot hazard if it is done with reasonable care and includes only dead branches and the bottom or low-vigor living branches.

Gruenfeld, J. J., Wright, E., and Coulter, W. K.
Operation counterattack. Timberman 57(12):92-93, illus.

A popular account of deterioration studies of beetle-killed silver fir in northwestern Washington.

Hunt, John
Taxonomy of the genus Ceratocystis. Lloydia 19(1):1-58, illus.

The genus Ceratocystis contains many fungi of economic importance, including the species that cause Dutch elm disease and oak wilt. Other species cause diseases of crop plants, some are associated with stain of forest products, and others are known to be associated with insect attacks on wood. The paper is a systematic treatment of the genus, with 39 species recognized.

Wright, Ernest, Coulter, W. K., and Gruenfeld, J. J.
Deterioration of beetle-killed Pacific silver fir. Jour. Forestry 54:322-325.

To assist in salvage operations, the average annual rate of decay was determined for beetle-killed trees.

_____ and Isaac, Leo A.
Decay following logging injury to western hemlock, Sitka spruce, and true firs. U. S. Dept. Agr. Tech. Bul. 1148, 34 pp., illus.

Decay under logging scars is usually rapid and extensive, especially in western hemlock and true firs. The variables affecting this decay are discussed, and a method is given for calculating the probable amount of decay and its rate of development.

Fire

Cramer, O. P.
Forest fire weather in western Oregon and western Washington in 1956. Pacific Northwest Forest and Range Expt. Sta. Res. Note 134, 8 pp., illus. (Processed.)

Fire weather of slightly below normal severity was indicated by three indexes for the regular April-October fire season. Lightning storms were most frequent of the 1950-1956 period.

Insects

Hagenstein, W. D., and Furniss, R. L.
Cooperation speeds salvage of windthrown and beetle-killed timber in Oregon and Washington. Soc. Amer. Foresters Proc. 1955:167-168.

Discussion of cooperative efforts to salvage 15 billion board-feet of timber killed by beetles or blown down during the years 1951-54.

Wear, J. F., and Lauterbach, P. G.
Color photographs useful in evaluating mortality of Douglas-fir. Soc. Amer. Foresters Proc. 1955:169-171.

Large-scale, aerial color transparencies are shown superior to panchromatic photo prints for evaluating tree mortality caused by the Douglas-fir beetle.

(Whiteside, J. M.)
Important forest insect outbreaks in 1956 in Oregon and Washington. Pacific Northwest Forest and Range Expt. Sta., 4 pp. (Processed.)

Summary of the principal forest insect infestations during the year.

Whiteside, J. M.
Spruce budworm control in Oregon and Washington, 1949-1956. Pacific Northwest Forest and Range Expt. Sta., 23 pp., illus. (Processed.)

Report on organization, conduct, and accomplishments of a cooperative, 7-year, 3,840,000-acre aerial spraying project successfully conducted against the budworm.

_____, Wessela, C. P., and Compton, L. M.
Report of the 1955 Oregon spruce budworm control project. Pacific Northwest Forest and Range Expt. Sta., 60 pp., illus. (Processed.)

Detailed account of the 621,000-acre, concluding phase of a 7-year spraying campaign to control the budworm.

Wright, K. H., and Baisinger, D. H.
The silvicultural importance of the Sitka spruce weevil in coastal Oregon and Washington. Soc. Amer. Foresters Proc. 1955:64-67.

Habits of the weevil are briefly discussed and preliminary findings are presented regarding the effects of weeviling upon Sitka spruce plantations.

FOREST ECONOMICS

Baudendistel, M. E.
Current timber inventory. Timberman 57(9):82-86, illus.

A brief summary of present timber volumes nationwide and for the Pacific Northwest with some information on species, tree sizes, and ownerships.

Corder, S. E., and Gedney, D. R.
Mill residues in 3 Oregon counties. Oreg. Forest Prod. Lab. Inform. Cir. 8, 34 pp., illus.

The volume of wood residue from plywood and sawmills in Linn, Lincoln, and Jackson Counties was determined. Particular emphasis was placed on coarse residue because of its use for pulp or fiber.

Cowlin, R. W.
The TRR and the Pacific Northwest. Timberman 57(9):78, illus.

A brief introduction to a series of articles on major subjects covered by the Timber Resource Review. It lists the broad basic assumptions of the TRR and relates the forest economy of the Pacific Northwest with that of the Nation.

Gedney, D. R.
Annual cut and timber products output in the Pacific Northwest in 1952. Pacific Northwest Forest and Range Expt. Sta. Forest Survey Rpt. 126, 29 pp., illus. (Processed.)

A study of the drain on timber resources due to cutting for timber products, and detailed descriptions of the output of major timber products in the region.

Public and private forest landownership in the Pacific Northwest shows stability. Pacific Northwest Forest and Range Expt. Sta. Res. Note 131, 3 pp., illus. (Processed.)

Ownership of forest land between the 1930's and 1953 shows little overall change. Private ownership has gradually become stabilized, county ownership has decreased, and State and Federal ownerships have increased.

Gedney, D. R.
Timber utilization. Timberman 57(9):86-87, illus.

One of a series based on the Timber Resource Review, this article deals with timber utilization in the Pacific Northwest. Shows the relation between timber products in the Northwest and those in the other timber producing areas in the United States.

_____ and Corder, S. E.
Residue use is basis for pulp industry expansion. Timberman 57(6):74-78, illus.

Annual rate of production of coarse sawmill residues were determined for Linn, Lincoln, and Jackson Counties, and for western Oregon. Potential pulp capacity based on utilization of these resources is discussed.

_____ and Mayer, C. E.
Forest statistics for Hood River Co., Oregon. Pacific Northwest Forest and Range Expt. Sta. Forest Survey Rpt. 125, 28 pp., illus. (Processed.)

A statistical report presenting results of a recent reinventory of the county's forests. Contains information about forest land area and ownership, and timber volumes and utilization. Some descriptive and interpretative information is included also.

_____ and Twerdal, M. P.
Forest statistics for Klickitat Co., Washington. Pacific Northwest Forest and Range Expt. Sta. Forest Survey Rpt. 124, 27 pp., illus. (Processed.)

A statistical report presenting results of a recent reinventory of the county's forests. Contains information about forest land area and ownership, and timber volumes and utilization. Some descriptive and interpretative information is included also.

McClay, T. A.

Future timber requirements and supply. Timberman 57(11):94-95, illus.

A short discussion of current consumption and projected future requirements for timber products in the United States and Coastal Alaska. Figures on growth and timber inventory needed to meet expected demands are included. Projections are made to 1975 and 2000.

Moravets, F. L.

Nation's commercial forest land. Timberman 57(9):80-82, illus.

One of a series of digests of essential facts, set forth by the Timber Resource Review, dealing with the extent and character of the commercial forest land in the Nation, with particular emphasis on the Pacific Northwest.

_____

Oregon's hardwood resources. Pacific Coast Hardwoods, March:11-14.

Covers the geographic range, extent of occurrence, character of timber growth, estimated sawtimber volume, and past utilization of the 12 commercial hardwood species native to Oregon.

Pope, R. B.

Timber growth and cut. Timberman 57(10):94-95, illus.

A summary of growth and cut data from the Timber Resource Review, with special emphasis on the Pacific Northwest.

_____

Timber mortality estimates from aerial photos. Forestry Chron. 32(3):360.

Current research studies are showing that the use of aerial photographs may aid the difficult job of sampling tree mortality. Both panchromatic and color photographs have been successfully used to evaluate standing mortality resulting from certain bark beetle epidemics. There is promise that continued studies will enable expansion of the technique to other types of mortality.

FOREST MANAGEMENT AND SILVICULTURE

Carmean, Willard H.

Suggested modifications of the standard Douglas-fir site curves for certain soils in southwestern Washington. Forest Sci. 2:242-250, illus.

When stands are less than 100 years old, the standard curves overestimate site quality on sands and gravels and underestimate site quality on imperfectly drained soils. Desirability of additional yield-table and site-curve studies for these soils is indicated.

Dimock, Edward J. II

Peelers from pruned Douglas-fir. Timberman 57(9):74-76, illus.

A study to discover some of the factors that will be met in peeling pruned Douglas-fir.

Selection thinning in young-growth Douglas-fir. Pacific Northwest Forest and Range Expt. Sta. Res. Note 127, 6 pp., illus. (Processed.)

A 6-year progress report on a selection thinning experiment, giving yields, increment, and costs. Records are taken from four bi-annual cuttings.

Duffield, John W.

Damage to western Washington forests from November 1955 cold wave. Pacific Northwest Forest and Range Expt. Sta. Res. Note 129, 5 pp., illus. (Processed.)

Damage to conifers and hardwoods from the November 1955 cold wave was surveyed by species and area in western Washington. Data is presented on timing and severity of the cold wave. Damage was heaviest to western hemlock and western red cedar. Douglas-fir damage was intermediate, and Sitka spruce and the true firs sustained relatively light damage.

Gratkowski, H. J.

Windthrow around staggered settings in old-growth Douglas-fir. Forest Sci. 2:60-74, illus.

Southwest winds were responsible for about 90 percent of the windthrow on a study area in the Cascade Range. Wind behavior in the area was affected by topography and cutting boundaries. Suggestions are presented for reducing windthrow around edges of staggered settings.

Isaac, Leo A.

Place of partial cutting in old-growth stands of the Douglas-fir region. Pacific Northwest Forest and Range Expt. Sta. Res. Paper 16, 48 pp., illus. (Processed.)

A study is described of the effects of partial cutting in Douglas-fir old-growth stands. Sample plots in partially cut stands distributed from Oakridge, Oreg., to Darrington, Wash., were measured 5 to 15 years after cutting. Mortality exceeded growth, giving an average net loss of 941 board-feet per acre for the first 10 years after logging. More than one-third of the trees had tractor damage. Since a large portion of these trees were thin-barked species subject to decay following such damage, the actual loss was even greater. Regeneration of tolerant species commonly followed, but Douglas-fir was not reported except in large openings. The partial-cutting system, as carried on during the 30's, has not been a successful method of harvesting the crop and converting the normal virgin forests of Douglas-fir to new or thrifty stands on average or better sites in the region.

_____

Silviculturist emphasizes need for better trees. Lumberman 83(9):72-75.

A step by step approach to improvement of trees in the Pacific Northwest, with comparisons of similar work in Europe.

Isaac, Leo A.
Where do we stand with Douglas-fir natural regeneration research. Soc. Amer. Foresters Proc. 1955:70-72.

A brief review of knowledge and of progress in assisting natural regeneration by artificial means.

Johnson, F. A.
Estimating allowable cut without a type map in forests of western Oregon and western Washington. Jour. Forestry 54:522-524.

Forest area statistics, if obtained from type maps, are possibly too subjective for the allowable cut estimate. An experiment in which forest areas are obtained by sampling is described and discussed.

Use of a bark thickness--tree diameter relationship for estimating past diameters of ponderosa pine trees. Pacific Northwest Forest and Range Expt. Sta. Res. Note 126, 3 pp., illus. (Processed.)

If bark growth is ignored in determining total diameter growth from increment cores, estimates of volume growth will be exposed to a large bias. This paper provides a technique for avoiding such bias.

Ruth, R. H.
Plantation survival and growth in two brush-threat areas in coastal Oregon. Pacific Northwest Forest and Range Expt. Sta. Res. Paper 17, 14 pp., illus. (Processed.)

Describes factors affecting survival and growth of trees planted in areas of severe brush competition. Recommendations are made for improving stocking in such areas in the Oregon Coast Range.

Ruth, R. H. and Berntsen, C. M.
Chemical basal treatment to control red alder. Pacific Northwest Forest and Range Expt. Sta. Res. Note 128, 6 pp., illus. (Processed.)

Describes how red alder trees up to 6 inches in diameter were killed by basal applications of hormone-type herbicides applied during the growing season.

Silen, Roy R.
Pacific NW advances forest genetics program. Lumberman 83(9):76-79.

A summary of the studies in forest genetics presently underway in the Pacific Northwest.

Use of temperature pellets in regeneration research. Jour. Forestry 54:311-312, illus.

A discussion of the various uses of commercially available temperature pellets to record surface temperature levels that are lethal to coniferous seedlings.

Staebler, George R.
Effect of controlled release on growth of individual Douglas-fir trees. Jour. Forestry 54:567-568, illus.

Preliminary results of a "spot thinning" study in a 41-year-old well-stocked stand on the Wind River Experimental Forest. Greatest response of diameter growth occurred on the dominant trees.

Evidence of shock following thinning of young Douglas-fir. Jour. Forestry 54:339.

How reduction in height growth is considered to be evidence of shock following very radical thinnings in a 23-year-old plantation.

Tarrant, Robert F.

Bibliography of Pacific Northwest forest soils publications through 1955. Pacific Northwest Forest and Range Expt. Sta. Res. Note 130, 5 pp. (Processed.)

Compilation of forest soils research publications for the Pacific Northwest for all years through 1955.

Changes in some physical soil properties after a prescribed burn in young ponderosa pine. Jour. Forestry 54:439-441, illus.

In this study of a medium-textured soil, prescribed burning did not harm and may have slightly improved the permeability and associated physical properties of the soil.

Effect of slash burning on some physical soil properties. Forest Sci. 2:18-22, illus.

Severe burning seriously lowered the rate of moisture movement in the two soils studied. Light burning did not hamper water movement within the surface 3 inches of soil.

Effects of slash burning on some soils of the Douglas-fir region. Soil Sci. Soc. Amer. Proc. 20(3):408-411, illus.

Although severe burning damages some soil properties, the amount of soil surface affected by severe burning usually represents only a small portion of the total area logged and burned. In weighing the effects of slash burning on soil properties, consideration must first be given to the relative amounts of lightly burned, severely burned, and unburned soil surface. This is necessary to avoid the possibility of assigning to an entire area, the effects of only the most severe burning treatment.

Forest soils of the Pacific Northwest. Soc. Amer. Foresters Proc. 1955:73-76, illus.

Description of broad soil differences found over Oregon and Washington.

Worthington, Norman P.
Thinning--a technique to increase values from forest land. Pacific Logging Cong. Proc., Loggers Handbook 16:69-71.

A discussion of how thinnings increase financial yields from forest lands, quoting three examples.

FOREST PRODUCTS UTILIZATION

Matson, E. E.
Lumber grades from old-growth Douglas-fir sawmill logs. Pacific Northwest Forest and Range Expt. Sta. Res. Note 125, 2 pp., illus. (Processed.)

Combines results from four old-growth Douglas-fir lumber-recovery studies. Shows lumber grade expectancy from Nos. 2 and 3 Sawmill logs.

Needed: economical new methods of logging young-growth western softwoods. Forest Prod. Jour. January:15-18, illus.

Discusses problems arising in logging operations due to the conversion from old-growth timber to young-growth timber.

The Wyssen skyline system. Soc. Amer. Foresters Proc. 1955:116-117.

Discusses results of an experimental logging operation using the Wyssen skyline crane on mountainous areas.

Young Douglas-fir makes good lumber. Lumberman 83(2):84, 114.

Summarizes data from several studies on lumber recovery from young-growth Douglas-fir.

Costello, David F.
Ecological classification as a basis for interpretation of range vegetation response. Soc. Amer. Foresters Proc. 1955:40-42.

Points out the need for an ecological classification of range sites for measurements of forage value and the detection of upward or downward trend.

_____
Factors to consider in the evaluation of vegetation condition. Jour. Range Mangt. 9:73-74.

A discussion of factors that should be evaluated and used in the formulation of range condition standards.

_____
Livestock distribution for efficient range use. In 1956 Stockmen's Handbook, pp. 26-27. Inst. Agr. Sci., State Col. of Wash. (Processed.)

Summarizes methods of supervising cattle and sheep herds to obtain uniform forage utilization.

Garrison, George A., and Moore, A. W.
Relation of the Dalles pocket gopher to establishment and maintenance of range grass plantings. Jour. Range Mangt. 9:182-184, illus.

Describes damage caused by Dalles pocket gophers to range grass plantings, and suggests control measures based on seedbed preparation and selection of grass species.

Goebel, Carl J.
Water development on the Starkey Experimental Forest and Range. Jour. of Range Mangt. 9:232-234, illus.

A description of water developments for livestock on the Starkey range in eastern Oregon. Benefits of available water are listed.

Harris, Robert W.

Management of cattle on summer ranges. In 1956 Stockmen's Handbook, pp. 146-148. Inst. Agr. Sci., State Col. of Wash. (Processed.)

Discusses the integration of rate of stocking, season of use, and distribution of cattle, into a planned management program for efficient use of the range.

WATERSHED MANAGEMENT

Dunford, E. G.

A watershed research program for the Pacific Northwest. Soc. Amer. Foresters Proc. 1955:190-195.

Describes physical characteristics of the Pacific Northwest as they affect problems of erosion and water yield on forest and range lands. A broad plan for watershed management research is given.

GENERAL

Johnson, F. A.

Specifications for processing mill scale study data on a type 650 electronic machine. Pacific Northwest Forest and Range Expt. Sta. Res. Note 133, 10 pp., illus. (Processed.)

The analysis procedure described in this publication saved approximately $500 over conventional data-processing methods.

Staebler, George R.

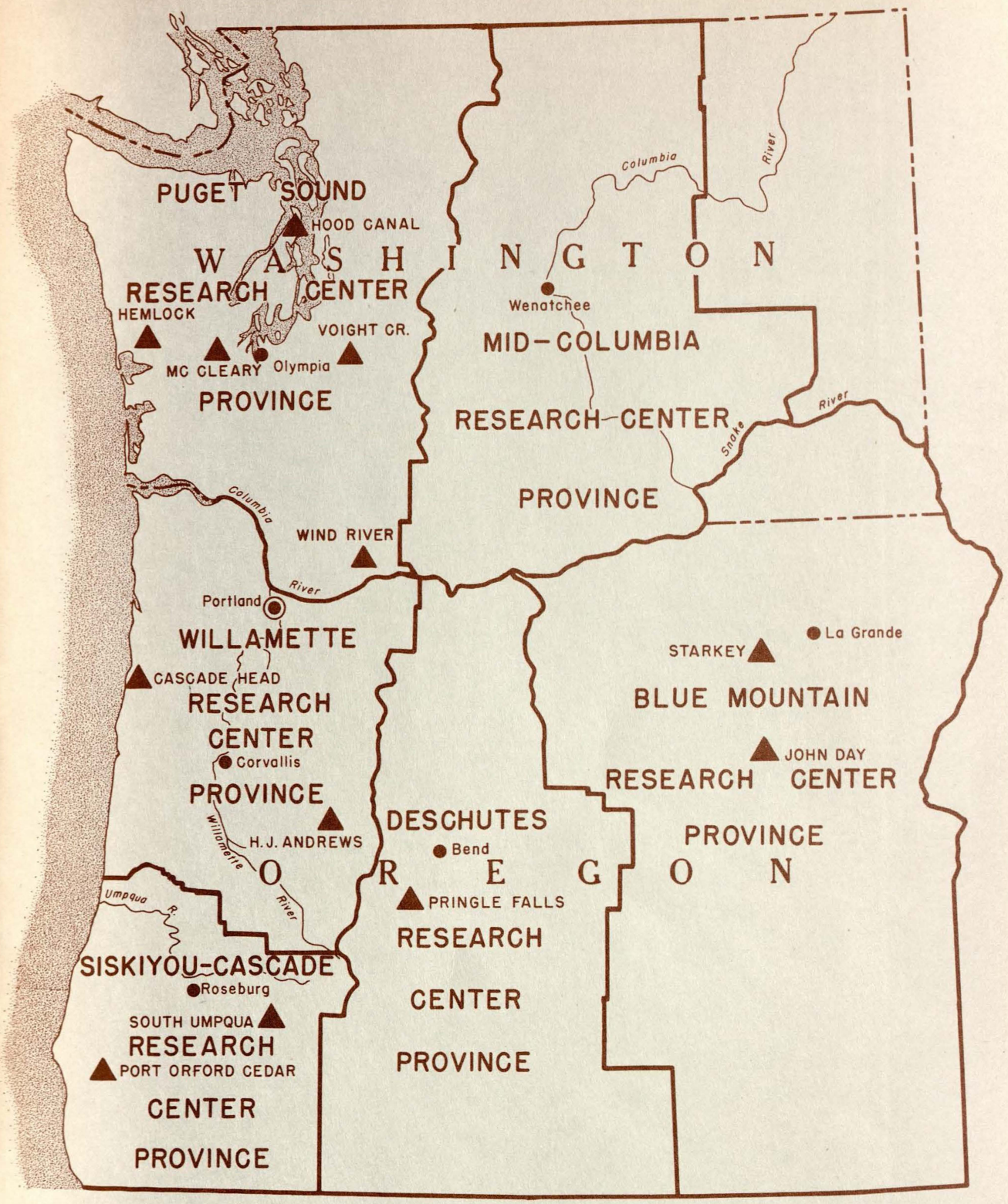
The need for research in forestry. Wash. State Forestry Conf. Proc. 1955:13-19.

Discussion of why the forest industry is being inadequately served by research. Points out those forestry fields most in need of expanded research efforts.

Station Staff

Pacific Northwest Forest and Range Expt. Sta. An. Rpt. 1955, 84 pp., illus. (Processed.)

Summary of Station research accomplishments during calendar year 1955 and plans for 1956.



RESEARCH CENTER PROVINCE

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION

● Research Center Headquarters

▲ Experimental Forests and Ranges

GPO 989412